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ANNUAL REPORT

OF THE

LIGHT-HOUSE BOARD

TO THE

SECRETARY OF THE TREASURY

FOR THE

FISCAL YEAR ENDED JUNE 30, 1893.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

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TREASURY DEPARTMENT,
Document No. 1647.
Office of Light-House Board.

LIGHT-HOUSE BOARD OF THE UNITED STATES.

Organized in conformity to the act of Congress approved August 31, 1852.

LIST OF MEMBERS ON JULY 1, 1893.

Hon. JOHN G. CARLISLE, Secretary of the Treasury, *ex officio* president.
Mr. WALTER S. FRANKLIN.
Prof. THOMAS C. MENDENHALL, Superintendent of the U. S. Coast and Geodetic Survey.
Rear-Admiral JAMES A. GREER, U. S. Navy.
Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army.
Capt. ROBLEY D. EVANS, U. S. Navy.
Col. JOHN M. WILSON, Corps of Engineers, U. S. Army.
Capt. GEORGE DEWEY, U. S. Navy.
Maj. HENRY M. ADAMS, Corps of Engineers, U. S. Army.

EXECUTIVE MEMBERS OF THE BOARD.

Chairman.—Rear-Admiral JAMES A. GREER, U. S. Navy.
Naval Secretary.—Capt. ROBLEY D. EVANS, U. S. Navy.
Engineer Secretary.—Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army.

OFFICERS IN CHARGE OF LIGHT-HOUSE DISTRICTS.

FIRST DISTRICT.

Inspector.—Commander FRANK WILDES, U. S. Navy, to September 15, 1892; Commander MERRILL MILLER, U. S. Navy, to April 1, 1893; Commander GEORGE E. WINGATE, U. S. Navy, Portland, Me., from April 1, 1893.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

SECOND DISTRICT.

Inspector.—Commander GEORGE F. F. WILDE, U. S. Navy, Boston, Mass.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

THIRD DISTRICT.

Inspector.—Capt. WINFIELD S. SCHLEY, U. S. Navy, Tompkinsville, N. Y.
Engineer.—Maj. DAVID PORTER HEAP, Corps of Engineers, U. S. Army, Tompkinsville, N. Y.

FOURTH DISTRICT.

PURNELL F. HARRINGTON, U. S. Navy, Philadelphia, Pa.
D MAGUIRE, Corps of Engineers, U. S. Army, to October
A. MAHAN, Corps of Engineers, U. S. Army, Philadelphia,

FIFTH DISTRICT.

CHARLES J. TRAIN, U. S. Navy, to December 31, 1892; Com-
T. S. Navy, Baltimore, Md., from December 31, 1892.
ERGLAND, Corps of Engineers, U. S. Army, Baltimore, Md.

SIXTH DISTRICT.

JAMES G. GREEN, U. S. Navy, to June 23, 1893; Lieut. Com-
IE, U. S. Navy, Charleston, S. C., from June 23, 1893.
ERGLAND, Corps of Engineers, U. S. Army, Baltimore, Md.

SEVENTH DISTRICT.

WILLIAM B. NEWMAN, U. S. Navy, Pensacola navy-yard,

. QUINN, Corps of Engineers, U. S. Army, New Orleans, La.

EIGHTH DISTRICT.

DENNIS W. MULLAN, U. S. Navy, New Orleans, La.
. QUINN, Corps of Engineers, U. S. Army, New Orleans, La.

NINTH DISTRICT.

NICOLL LUDLOW, U. S. Navy, to December 15, 1892; Com-
T. S. Navy, Chicago, Ill., from December 15, 1892.
O M. POE, Corps of Engineers, brevet brigadier-general,
14, 1892; Maj. MILTON B. ADAMS, Corps of Engineers, U.
rom December 14, 1892.

TENTH DISTRICT.

EDWIN T. WOODWARD, U. S. Navy, to June 27, 1893; Com-
U. S. Navy, Buffalo, N. Y., from June 27, 1893.
JARED A. SMITH, Corps of Engineers, U. S. Army, Cleve-

ELEVENTH DISTRICT.

EDWIN T. WOODWARD, U. S. Navy, to July 15, 1892; Com-
S. Navy, to May 31, 1893; Commander WILLIAM W. MEAD,
., from May 31, 1893.
O M. POE, Corps of Engineers, brevet brigadier-general,
14, 1892; Maj. MILTON B. ADAMS, Corps of Engineers, U. S.
m December 14, 1892.

TWELFTH DISTRICT.

THOMAS PERRY, U. S. Navy, to December 31, 1892; Com-
LS, U. S. Navy, San Francisco, Cal., from December 31, 1892.
M H. HEUER, Corps of Engineers, U. S. Army, San Fran-

THIRTEENTH DISTRICT.

Inspector.—Lieut. Commander WILLIAM W. RHOADES, U. S. Navy, to July 31, 1892; Commander OSCAR W. FARENHOLT, U. S. N., Portland, Oregon, from July 31, 1892.

Engineer.—Maj. THOMAS H. HANDBURY, Corps of Engineers, U. S. Army, Portland, Oregon.

FOURTEENTH DISTRICT.

Inspector.—Commander EDWIN M. SHEPARD, U. S. Navy, to May 1, 1893; Lieut. Commander F. W. CROCKER, U. S. Navy, Cincinnati, Ohio, from May 1, 1893.

Engineer.—Lieut. Col. AMOS STICKNEY, Corps of Engineers, U. S. Army, Cincinnati, Ohio.

FIFTEENTH DISTRICT.

Inspector.—Commander WILLIAM C. WISE, U. S. Navy, St. Louis, Mo.

Engineer.—Lieut. Col. CHARLES R. SUTER, Corps of Engineers, U. S. Army, St. Louis, Mo.

SIXTEENTH DISTRICT.

Inspector.—Lieut. Commander ROBERT M. BERRY, U. S. Navy, to December 31, 1892; Commander ANDREW J. IVERSON, U. S. Navy, Memphis, Tenn., from December 31, 1892.

Engineer.—Lieut. Col. CHARLES R. SUTER, Corps of Engineers, U. S. Army, St. Louis, Mo.

REPORT

OF

THE UNITED STATES LIGHT-HOUSE BOARD.

TREASURY DEPARTMENT,
OFFICE OF THE LIGHT-HOUSE BOARD,
Washington, D. C., November 13, 1893.

SIR: The Light-House Board has the honor to submit, for your information and that of Congress, the following report of the work done under its direction during the fiscal year which ended on June 30, 1893.

At the close of the year there were under the control of the Light-House Establishment the following-named aids to navigation:

Light-houses and beacon lights, including the 361 post lights in the third, fourth, fifth, sixth, eighth, twelfth, and thirteenth light-house districts	1,312
Light-ships in position	33
Light-ships for relief	6
Electric buoys in position	20
Gas buoys in position	2
Fog signals operated by steam or hot air	114
Fog signals operated by clockwork	189
Post lights on the Western rivers	1,389
Post lights on other rivers	361
Day or unlighted beacons	419
Whistling buoys in position	64
Bell buoys in position	90
Other buoys in position, including pile buoys and stakes in fifth district and buoys in Alaskan waters	4,315

In the construction, care, and maintenance of these aids to navigation there were employed:

Steam tenders	30
Steam launches	8
Sailing tenders	2
Light-keepers	1,139
Other employés, including crews of light-ships and tenders	821
Laborers in charge of Western river lights	1,135
Laborers in charge of other river post lights	368

NEW LIGHTS.

new lights were established during the fiscal

... Light, No. 6, Thames River, Connecticut.—A ... ght reestablished, July 16, 1892.

... Light, St. Croix River, Maine.—A tubular- ... y 15, 1892.

... pier Sound, Maryland.—A fourth-order light,

... Michigan.—A fifth-order light, August 16,

... River, Michigan.—A lens-lantern light, Au-

... St. Marys River, Michigan.—Two lens-lantern ... 892.

... Marys River, Michigan.—A lens-lantern light,

... ge, St. Marys River, Michigan.—Two tubular- ... ugust, 1892.

... ge, St. Marys River, Michigan.—Two tubular- ... gust, 1892.

... St. Marys River, Michigan.—Two tubular-lan- ... st, 1892.

... bish Island Range, St. Marys River, Michigan.— ... rn lights, August, 1892.

... St. Marys River, Michigan.—Two tubular-lantern ... 92.

... St. Marys River, Michigan.—Two tubular-lantern ... 92.

... Marys River, Michigan.—Two tubular-lantern ... 92.

... e George, St. Marys River, Michigan.—A tubular- ... gust, 1892.

... ke George, St. Marys River, Michigan.—A tubu ... August, 1892.

... ake George, St. Marys River, Michigan.—A lens- ... ust, 1892.

... rge, St. Marys River, Michigan.—A lens lantern ... 2.

... Marys River, Michigan.—A lens-lantern light,

... Little Lake George, St. Marys River, Michigan.— ... n lights, August, 1892.

... Lake George, St. Marys River, Michigan.—Two ... hts, August, 1892.

Palmers Point, Little Lake George, St. Marys River, Michigan.—A lens-lantern light, August, 1892.

Farmers Ridges Range, St. Marys River, Michigan.—Two tubular-lantern lights, August, 1892.

Partridge Point and Topsail Island Ranges, St. Marys River, Michigan.—Three tubular-lantern lights, August, 1892.

Sault Range, St. Marys River, Michigan.—Two tubular-lantern lights, August, 1892.

Bayfield Rock Range, St. Marys River, Michigan.—Two tubular-lantern lights, August, 1892.

Harwood Point Range, St. Marys River, Michigan.—Two tubular-lantern lights, September 8, 1892.

South San Francisco Beacon Lights, San Francisco Bay, California.—Two tubular-lantern lights, September 10, 1892.

Round Island, St. Marys River, Michigan.—A lens-lantern light, September 20, 1892.

Tahiti Post Light, Hobe Sound, Indian River, Florida.—A tubular-lantern light, September 30, 1892.

Squaw Island, Lake Michigan, Michigan.—A fourth-order light, October 10, 1892.

St. George Reef, seacoast of California.—A first-order light, October 20, 1892.

Old Mackinac Point, Straits of Mackinac, Michigan.—A fourth-order light, October 25, 1892.

Conneaut Pierhead, Lake Erie, Ohio.—A lens-lantern light, November 11, 1892.

Meadows Post Light, Connecticut River, Connecticut.—A tubular-lantern light, December 15, 1892.

East Haddam Meadows Post Light, Connecticut River, Connecticut.—A tubular-lantern light, December 15, 1892.

Haddam Island Range Post Lights, Connecticut River, Connecticut.—Two tubular-lantern lights, December 15, 1892.

Siam Dock Post Light, Connecticut River, Connecticut.—A tubular-lantern light, December 15, 1892.

Pistol Point Range Post Lights, Connecticut River, Connecticut.—Two tubular-lantern lights, December 15, 1892.

Two Piers Channel Range Post Lights, Connecticut River, Connecticut.—Two tubular-lantern lights, December 15, 1892.

Press Barn Bar Range Post Lights, Connecticut River, Connecticut.—Two tubular-lantern lights, December 15, 1892.

Clay Bank Range Post Lights, Connecticut River, Connecticut.—Two tubular-lantern lights, December 15, 1892.

Maryland Point, Potomac River, Maryland.—A fourth-order light, December 15, 1892.

Wreck of the Queen of the West Post Light, Grand Lake, Louisiana.—A tubular-lantern light, January, 1893.

Lake Chicot Post Light, Louisiana.—A tubular-lantern light, January, 1893.

Obstruction Island Post Light, Rosario Strait, Washington Sound, Washington.—A tubular-lantern light, January 10, 1893.

Grant Farm (lower) Post Light, No. 9½, Indian River, Florida.—A tubular-lantern light, February 1, 1893.

Indian River Narrows (lower) Post Light, No 15, Indian River, Florida.—A tubular-lantern light, February 1, 1893.

Indian River Narrows (upper) Post Light, No. 20, Indian River, Florida.—A tubular-lantern light, February 1, 1893.

Amelia Island Range, entrance to Fernandina Harbor, Florida.—Two tubular-lantern lights, February 14, 1893.

Tiger Island North Range, entrance to Fernandina Harbor, Florida.—Two tubular-lantern lights, February 14, 1893.

Tiger Island South Range, entrance to Fernandina Harbor, Florida.—Two tubular-lantern lights, February 14, 1893.

Mangrove Point Beacon Light, Charlotte Harbor, Florida.—A lens-lantern light, February 20, 1893.

Peace Creek Beacon Light, Charlotte Harbor, Florida.—A lens-lantern light, February 20, 1893.

Middle Quarantine Shoal Post Light, No. 12, St. Johns River, Florida.—A tubular-lantern light, March 1, 1893.

Ahnapee Pierhead Range, Lake Michigan, Wisconsin.—One lens-lantern light and one tubular-lantern light, March 1, 1893.

Lake Beresford Post Light, No. 108, St. Johns River, Florida.—A tubular-lantern light, March 10, 1893.

Harris Bayou Post Light, Mississippi River, Louisiana.—A lens-lantern light, March, 1893.

Irontown Post Light, Mississippi River, Louisiana.—A lens-lantern light, March, 1893.

Poydras Hall Post Light, Mississippi River, Louisiana.—A lens-lantern light, March, 1893.

Old Orchard Shoal, New York Lower Bay, New York.—Two tubular-lantern lights (temporarily), March 23, 1893.

North River Bar Range, Albemarle Sound, North Carolina.—Two lens-lantern lights, March 23, 1893.

Skamokawa Slough (lower) Post Light, Columbia River, Oregon.—A tubular-lantern light, March 29, 1893.

Old Orchard Shoal, New York Lower Bay, New York.—A fourth-order light, April 25, 1893.

Wreck of the Bark Undine, Savannah River, Georgia.—A lantern light, April, 1893.

Green Flats Post Light, Hudson River, New York.—A tubular-lantern light, May 18, 1893.

Priming Hook Post Light, Hudson River, New York.—A tubular-lantern light, May 18, 1893.

Solomons Lump, Kedge Straits, Chesapeake Bay, Maryland.—A lens-lantern light (to mark the wreck of the light-house), June 10, 1893.

Superior Bay Entrance Range Post Lights, Superior Bay, Wisconsin.—Two lens-lantern lights, June 15, 1893.

Superior Bay Range Post Lights, Superior Bay, Wisconsin.—Two lens-lantern lights, June 15, 1893.

Quebec Channel Post Light, Superior Bay, Wisconsin.—A lens-lantern light, June 15, 1893.

Superior Bay Channel (lower) Post Light, Superior Bay, Minnesota.—A lens-lantern light, June 15, 1893.

Superior Bay Channel (lower middle) Post Light, Superior Bay, Minnesota.—A lens-lantern light, June 15, 1893.

Superior Bay Channel (upper middle) Post Light, Superior Bay, Minnesota.—A lens-lantern light, June 15, 1893.

Superior Bay Channel (upper) Post Light, Superior Bay, Minnesota.—A lens-lantern light, June 15, 1893.

Connors Point Range and Rice Point Range Post Lights, Superior Bay, Minnesota.—Three lens-lantern lights, June 15, 1893.

Ohio Central Coal Dock Post Light, Superior Bay, Minnesota.—A lens-lantern light, June 15, 1893.

North Channel East Range Post Lights, St. Louis Bay, Minnesota.—Two tubular-lantern lights, June 16, 1893.

North Channel West Range and South Channel West Range Post Lights, St. Louis Bay, Minnesota.—Three tubular-lantern lights, June 16, 1893.

Charleston Harbor Swash Channel Range Rear Light, Charleston Harbor, South Carolina.—A reflector light, June 24, 1893.

Wolf Trap Light-Vessel, Chesapeake Bay, Virginia.—Four tubular-lantern lights, June 30, 1893.

World's Fair Electric Buoys, Chicago Harbor, Illinois.—Thirteen electric lights, June, 1893.

NEW FOG SIGNALS.

During the fiscal year fog signals were established at the following-named existing light-stations:

Sherwood Point, Green Bay, Wisconsin.—A bell struck by machinery, July 1, 1892.

Nantucket New South Shoal Light-Vessel, Massachusetts.—A 12-inch steam whistle, November 13, 1892.

Martins Industry Light-Vessel, off Port Royal entrance, South Carolina.—A 12-inch steam whistle, November 30, 1892.

Cornfield Point Light-Vessel, Long Island Sound, Connecticut.—A 12-inch steam whistle, December 15, 1892.

Fenwick Island Shoal Light-Vessel, off the seacoast of Maryland.—A 12-inch steam whistle, December 15, 1892.

n Shoal Light-Vessel, off Cape Fear, North Carolina.—A h steam whistle, December 20, 1892.

Pierhead, Lake Michigan, Michigan.—A bell struck by inery, June 15, 1893.

ving-named new fog signals were established during the

Shoal, Tangier Sound, Maryland.—A bell struck by machin- August 1, 1892.

land, Lake Michigan, Michigan.—A 10-inch steam whistle, ber 10, 1892.

Island, off Cape Newagen, Maine.—A Daboll trumpet, De- er 15, 1892.

Point, Potomac River, Maryland.—A bell struck by inery, December 15, 1892.

p Light-Vessel, Chesapeake Bay, Virginia.—A steam whistle, 30, 1893.

LIGHTS DISCONTINUED.

ving-named lights were, in the course of the fiscal year, dis-

ad, Maryland.—A sixth-order light, August 1, 1892.

int Post Light, Connecticut River, Connecticut.—A tubular- rn light, August 10, 1892.

o Pierhead, Lake Michigan, Michigan.—A fifth-order light, ist 16, 1892.

and Post Light, No. 32, Indian River, Florida.—A tubular- rn light, September 30, 1892.

nd Range Beacon, entrance to Mobile Bay, Alabama.—A tor light, November 21, 1892.

ocks (lower) Post Light, Connecticut.—A tubular-lantern light, mber 15, 1892.

Pier Post Light, Connecticut River, Connecticut.—A tubular- rn light, December 15, 1892.

's Channel Post Light, Connecticut River, Connecticut.—A lar-lantern light, December 15, 1892.

sland Range, entrance to Fernandina Harbor, Florida.—Two tor lights, December 11, 1892.

Point, Elizabeth River, Virginia.—A fifth-order light, Decem- 1, 1892.

Point Wreck Post Light, No. 29, St. Johns River, Florida.— bular lantern light, January 4, 1893.

p, Chesapeake Bay, Virginia.—A fourth-order light, January 893. (Station carried away by ice.)

Lump, Kedge Straits, Chesapeake Bay, Maryland.—A fifth- r light, February 2, 1893. (Station carried away by ice.)

Dame Point Post Light, No. 5, St. Johns River, Florida.—A tubular-lantern light, February, 1893.

Dame Point, St. Johns River. Florida.—A fifth-order light, February 28, 1893.

Cleveland, Cleveland Harbor, Lake Erie, Ohio.—A three-and-one-half order light, opening of navigation, 1893.

Old Orchard Shoal, New York Lower Bay, New York.—Two tubular-lantern lights, April 25, 1893.

San Carlos Creek Post Light, No. 8, St. Johns River, Florida.—A tubular-lantern light, structure carried away May, 1893. (Will not be rebuilt.)

FOG SIGNALS DISCONTINUED.

Lambert Point, Elizabeth River, Virginia.—A bell struck by machinery, December 31, 1892.

Wolf Trap, Chesapeake Bay, Virginia.—A bell struck by machinery, January 22, 1893. (Station carried away by ice).

Solomons Lump, Kedge Straits, Chesapeake Bay, Maryland.—A bell struck by machinery, February 2, 1893. (Station carried away by ice).

CHANGES IN LIGHTS.

During the fiscal year the following changes were made in existing lights:

North Dumpling, Fishers Island Sound, New York.—Changed from a light of the sixth order to a light of the fifth order, July 21, 1892.

Rockland Breakwater, Rockland Harbor, Maine.—Changed from one fixed white lens-lantern light to two fixed red lens-lantern lights, one vertically above the other, August 15, 1892.

Delaware Breakwater Range (front), entrance to Delaware Bay, Delaware.—Changed from fixed white varied by a white flash every 45 seconds to fixed white during periods of two and one-half seconds, separated by eclipses of two and one-half seconds duration, September 15, 1892.

South Narrows Post Light, Indian River, Florida.—The number was changed from 34 to 32, September 30, 1892.

Liberty Enlightening the World, New York Bay, New York.—Changed to show, in addition to the fixed white electric light from the torch and the pedestal illuminated by lights in the salients of the fort, a vertical beam of red and yellow light seen above the torch only by reflection from the haze and dust in the air, the face and bust of the statue illuminated by a search light and the coronet decorated with red, white, and blue lights, October 21, 1892.

Reedy Island, Delaware River, Delaware.—Changed from a flashing light of the fifth order to a fixed light of the fourth order, illuminating 270 degrees of the horizon, extending from SSE. through northward, eastward, and southward to ENE., November 30, 1892. The light shows white from SSE. through northward and eastward to N. by E. ⅞ E., except in the narrow sector between N. by W. and N. ⅜ E., in which the light shows red. From N. by E. ⅞ E. to ENE. the light shows red. The easterly red sector and the easterly edge of the westerly red sector remain as they were.

Milwaukee, Lake Michigan, Wisconsin.—Changed from a fixed white light varied by a white flash every two minutes, to a fixed white light varied by a white flash every forty-five seconds, December 6, 1892.

Kenosha (Southport), Lake Michigan, Wisconsin.—Changed from a fixed white light varied by a white flash every ninety seconds, to a fixed white light varied by a white flash every forty-five seconds, December 6, 1892.

St. Joseph, Lake Michigan, Michigan.—Changed from a fixed white light varied by a white flash every ninety seconds to a fixed white light varied by a white flash every forty-five seconds, December 8, 1892.

Grand Haven, Lake Michigan, Michigan.—Changed from a fixed white light varied by a white flash every ninety seconds to a fixed white light varied by a white flash every minute, December 10, 1892.

White River, Lake Michigan, Michigan.—Changed from a fixed white light varied by a red flash every minute to a fixed white light varied by a red flash every forty seconds, December 12, 1892.

Calves Island Post Light, Connecticut River, Connecticut.—Changed from a fixed white to a fixed red light, December 15, 1892.

Essex Reef Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Joshua Rocks (upper) Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Deep River Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Chester Rock Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Rock Landing Post Light, Connecticut River, Connecticut.—Changed from a fixed white to a fixed red light, December 15, 1892.

Paper Rock Post Light, Connecticut River, Connecticut.—Changed from a fixed white to a fixed red light, December 15, 1892.

Bodkin Rock Post Light, Connecticut River, Connecticut.—Changed from a fixed white to a fixed red light, December 15, 1892.

Mouse Island (lower) Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Colt Pier Range (front) Post Light, Connecticut River, Connecticut.—Changed from a fixed red to a fixed white light, December 15, 1892.

Cornfield Point Light-Vessel, Long Island Sound, New York.—Changed from a fixed red reflector light to show simultaneously from four lens lanterns encircling the mainmasthead a fixed white electric light during periods of twelve seconds, separated by eclipses of three seconds' duration, December 15, 1892.

Hell Gate Post Light, East River, New York.—Changed from a fixed white light to one showing alternately red and white, each for three seconds, December 31, 1892.

Old Plantation Flats, Chesapeake Bay, Virginia.—Changed from a fourth order to a fifth-order light, February 3, 1893. (Fourth-order lens broken by ice in January, 1893.)

Cape Fear, seacoast of North Carolina.—Changed from flashing red every thirty seconds to flashing white every thirty seconds, March 8, 1893.

Sombrero Key, Florida Reefs, Florida.—Changed from fixed white to fixed white with three fixed red sectors, April 29, 1893. The northerly red sector extends from S. by E. ¾ E. eastward to SW. ½ S. The easterly red sector extends from SW. by W. southward to WSW. ⅝ W. The westerly fixed red sector extends from ENE. northward to E. ¼ S.

Fowey Rocks, Florida Reefs, Florida.—Changed from fixed white to fixed white with three fixed red sectors, April 30, 1893. The northerly red sector extends from S. ¼ E. eastward to S. ⅜ W. The southerly red sector extends from N. ¼ W. westward to N. by E. ¾ E. The westerly red sector extends from E. ¼ N. northward to E. ¾ S.

Carysfort Reef, Florida Reef, Florida.—Changed from flashing white to flashing white with three flashing red sectors, April 30, 1893. The northerly red sector extends from S. ⅛ W. eastward to SSW. ½ W. The southwesterly. red sector extends from NNE. ⅛ E. westward to NE. ⅛ E. The northwesterly red sector extends from E. ½ N. northward to SE. ⅝ S.

Alligator Reef, Florida Reefs, Florida.—The limits of the red sectors were changed April 30, 1893, as follows: The northeasterly red sector was made to extend from SW. ⅜ S. eastward to SW. by W. ½ W.; the southwesterly red sector was made to extend from NE. ⅛ E. northward to NE. by E. ¾ E.

American Shoal, Florida Reefs, Florida.—Changed from flashing white to flashing white with three flashing red sectors, April 30, 1893. The easterly flashing red sector extends from SW. by

¼ W. southward to W. ¾ S. The westerly flashing red sector nds from NE. by E. ¾ E. northward to E. ¼ N. The north-terly flashing red sector extends from ESE. northward to ¾ E.

y, *Florida Reefs, Florida.*—Changed by the insertion of two itional sectors in which the light shows fixed red, varied by fla-hes, April 30, 1893. The northerly red sector (new) nds from S. ½ W. eastward to S. by W. ¾ W. The north-edge of the existing westerly red sector was changed from N. to E. ¾ N. The northwesterly red sector (new) extends SE. by E. ½ E. northward to SE. ¾ E.

t, *Florida Reefs, Florida.*—Changed from fixed white to fixed e with three fixed red sectors, April 30, 1893. The south-erly red sector extends from NW. ¼ N. westward to N. ¼ The southwesterly red sector extends from NE. ⅝ E. north-d to NE. by E. 1⅛ E. The northwesterly red sector nds from SE. ⅜ E. northward to SE. ¼ S.

st Passage, Northwest Channel into Key West Harbor, Florida.—nged from fixed white with one fixed red sector to fixed e with two fixed red sectors, April 30, 1893. The exist-northerly red sector was not changed. The southeasterly sector extends from NW. ¾ W. westward to NNW. ⅛ W.

Shoals, Florida Reefs, Florida.—Changed from flashing alter-ly red and white throughout the entire horizon to flashing rnately red and white, excepting from WSW. ¼ W. south-d to NW. by W. ⅛ W., in which sector every flash is red; il 30, 1893.

tugas, Loggerhead Key, Florida.—Changed from fixed white xed white with a fixed red sector, April 30, 1893. The red or extends from NE. by N. northward to ENE. ½ E.

Harbor, Garden Key, Florida.—Changed from fixed white to l white with three fixed red sectors, April 30, 1893. The herly red sector extends from S. eastward to SW. The erly red sector extends from SW. ¾ W. southward to W. The westerly red sector extends from NE. by E. ¼ E. hward to E. ¾ N.

atiot, head of St. Clair River, Michigan.—Changed from a l white light varied by a white flash every two minutes to a l white light varied by a white flash every minute, opening vigation, 1893.

n, Lake Huron, Michigan.—Changed from a fixed white light ed by a white flash every ninety seconds to a fixed white varied by a white flash every minute, opening of naviga- 1893.

hoal, New York Lower Bay, New York.—Changed from fixed o fixed white, May 31, 1893.

Whitefish Point, Lake Superior, Michigan.—Changed from fixed white to fixed white varied by a red flash every twenty seconds, June 15, 1893.

CHANGES IN FOG SIGNALS.

During the fiscal year the following described changes were made in fog signals:

Libby Islands, entrance to Machias Bay, Maine.—Changed to sound blasts of four seconds, separated by alternate silent intervals of four and eighteen seconds' duration, September 30, 1892.

Pollock Rip Light-Vessel, off Pollock Rip, Massachusetts.—Changed to a chime whistle, sounding blasts of five seconds, separated by silent intervals of twenty-five seconds' duration, October 31, 1892.

Great Round Shoal Light-Vessel, off Great Round Shoal, Massachusetts.—Changed to a 12-inch whistle, sounding blasts of five seconds, separated by silent intervals of fifty-five seconds' duration, October 31, 1892.

Hook Beacon, Sandy Hook, New Jersey.—Changed to an automatic siren, sounding blasts of three seconds, separated by silent intervals of seventeen seconds' duration, December 31, 1892.

Southwest Ledge, New Haven Harbor, Connecticut.—Changed from a second-class Daboll trumpet to a bell struck by machinery, a single blow every fifteen seconds, January 7, 1893.

Robbins Reef, New York Bay, New York.—Changed from a bell struck by machinery to a blower siren, sounding blasts of three seconds, separated by silent intervals of three seconds' duration, April 25, 1893.

CHANGES IN LOCATION.

The location of the following-named lights was changed during the fiscal year:

Sapelo Beacon, entrance to Doboy Sound, Georgia.—Moved 8 feet in a southwesterly direction, July 12, 1892.

Wolf Island Beacon, entrance to Doboy Sound, Georgia.—Moved 11 feet in a southerly direction, July 12, 1892.

Chicago Outer Breakwater (NW. end) Light, Chicago Harbor, Illinois.—Moved to Emergency Intake Waterworks Crib, and height increased to 45 feet, October 19, 1892.

Light-Vessel, No. 47.—Moved from Great Round Shoal to Pollock Rip light-vessel station, October 31, 1892.

Light-Vessel, No. 42.—Moved from Pollock Rip to Great Round Shoal light-vessel station, October 31, 1892.

Humboldt Light-Station, entrance to Humboldt Bay, California.—Moved about 5 miles S. by W. to Table Bluff, October 31, 1892.

Nantucket New South Shoal Light-Vessel, Massachusetts.—Moved about 10 miles southwesterly, November 13, 1892.

Rockland Breakwater, Rockland Harbor, Maine.—Moved 327 feet southerly, to the outer end of the finished breakwater, November 30, 1892.

Cornfield Point Light-Vessel, Long Island Sound, Connecticut.—Moved nearly five-eighths of a mile S. $\frac{5}{8}$ W., December 15, 1892.

Shaws Island Post Light, Grand Lake, Louisiana.—Moved about one-half mile southeasterly, January, 1893.

Bush Bluff Light-Vessel, No. 46, Elizabeth River, Virginia.—Moved about 50 yards to westward, February 6, 1893.

Linton Landing Post Light, Willamette River, Oregon.—Moved to saw-mill wharf at Linton and height increased to 25 feet, March 24, 1893.

Cathlamet Post Light, Columbia River, Oregon.—Moved to edge of abrupt bluff above the town of Cathlamet and height increased to 71 feet, April 7, 1893.

Superior Pierhead, entrance to Superior Bay.—Moved from the North Pier, Minnesota side, to the South Pier, Wisconsin side of the entrance, June 15, 1893.

Cape Poge Light, Marthas Vineyard, Massachusetts.—Moved 40 feet S. by W. $\frac{3}{4}$ W. to a new tower, June 26, 1893.

TEMPORARY CHANGES IN AIDS TO NAVIGATION.

During the fiscal year the following temporary changes were made in aids to navigation:

Dog River Bar Beacon, No. 1, Mobile Bay, Alabama.—Structure run into and damaged; light temporarily exhibited from a pole, July, 1892. Structure repaired and light displayed as usual, August 22, 1892.

Pascagoula River Range (rear), Mississippi Sound, Mississippi.—Structure damaged by lightning; light temporarily exhibited from a pole, July, 1892. Structure repaired and light displayed as usual, August 10, 1892.

Trinity Shoal Light-Vessel, No. 43, Louisiana.—Replaced on her station after being repaired, July 14, 1892.

Little Marsh Island Channel Range (front) Post Light No. 6, St. Johns River, Florida.—Destroyed August 17, 1892. Rebuilt and light displayed as usual, September 28, 1892.

St. George Reef Fog Signal, seacoast of California.—Run for periods of 20 minutes, separated by silent intervals of 20 minutes during foggy weather, owing to scarcity of water, September, 1892; placed in full operation again October 16, 1892.

Nantucket New South Shoal Light-Vessel, Massachusetts.—Relief Light Vessel, No. 9, withdrawn and station marked by Light-Vessel, No. 54, November 13, 1892.

Rattlesnake Shoal Light-Vessel, No. 38, off the entrance to Charleston Harbor, South Carolina.—Withdrawn from her station for repairs and position marked by a gas buoy showing a fixed white light, November 1, 1892. Gas buoy discontinued and Light-Vessel, No. 29 placed on the station, December 15, 1892. Light-Vessel, No. 29, withdrawn and replaced by Light-Vessel, No. 34, April 18, 1893.

Sandy Hook Light-Vessel, No. 48, off Sandy Hook, New Jersey, entrance to New York Lower Bay.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel, No. 16, November 17, 1892. Light-Vessel, No. 48, replaced on her station and Relief Light-Vessel, No. 16, withdrawn, January 16, 1893.

Martins Industry Light-Vessel, No. 34, off entrance to Port Royal, South Carolina.—Withdrawn from her station and replaced by Light-Vessel, No. 1, November 30, 1892.

Flushing Bay Post Light, East River, New York.—Carried away by ice and replaced by a light on a pole, January 9, 1893.

South Brother Island Ledge Post Light, East River, New York.—Carried away by ice and discontinued, January 9, 1893. Reëstablished, August 25, 1893.

Lawrence Point Ledge Post Light, East River, New York.—Carried away by ice and discontinued, January 9, 1893. Reëstablished, August 25, 1893.

Sunken Meadow Post Light, East River, New York.—Extinguished by ice, January 9, 1893.

Laurel Point, Albemarle Sound, North Carolina.—Light and fog signal discontinued on account of ice, January 11, 1893. Reëstablished, February, 1893.

Browns Head, entrance to Fox Island Thoroughfare, Maine.—Discontinued on account of ice, January 14, 1893. Reëstablished, March 25, 1893.

Bush Bluff Light-Vessel, No. 46, Elizabeth River, Virginia.—Dragged by ice about 300 yards from her position and anchor light shown, January 19, 1893. Replaced and regular lights reëstablished, February 6, 1893.

Smith Point, Chesapeake Bay, Virginia.—Light and fog signal discontinued on account of ice, January 20 to 31, 1893.

Currituck Sound Beacon, No. 6, North Carolina.—Carried away by ice January 22, 1893. Reëstablished March, 1893.

Currituck Sound Beacon, No. 7, North Carolina.—Damaged by ice and light discontinued January 22, 1893. Temporary light established February, 1893. Regular light reëstablished March, 1893.

Old Plantation Flats, Chesapeake Bay, Virginia.—Structure damaged by ice and light discontinued January, 1893. Light reëstablished February 3, 1893.

Cape Charles City Harbor Lights, Chesapeake Bay, Virginia.—Discontinued on account of ice January, and reëstablished February, 1893.

Hatteras Inlet, Pamlico Sound, North Carolina.—Light and fog signal discontinued on account of ice January 24. Reëstablished February, 1893.

Pumpkin Island, entrance to Eggemoggin Reach, Maine.—Discontinued owing to close of navigation by ice January 28. Relighted April 2, 1893.

Nantucket New South Shoal Light-Vessel No. 54, Massachusetts.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel No. 39, April 5, 1893. Light-Vessel No. 54 replaced on her station and Relief Light-Vessel No. 39 withdrawn June 21, 1893.

Cross Rip Light-Vessel No. 5, Nantucket Sound, Massachusetts.—Withdrawn from her station for repairs and replaced by Light-Vessel No. 9 April 10, 1893. Light-Vessel No. 5 replaced on her station and Relief Light-Vessel No. 9 withdrawn April 22, 1893.

McWilliams Point Shoal, Pamlico River, North Carolina.—Structure damaged April 21, 1893. Hand lantern shown until rebuilt and regular light reëstablished July, 1893.

Shovelful Shoal Light-Vessel No. 3, eastern entrance to Nantucket Sound, Massachusetts.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel No. 9 April 24, 1893. Light-Vessel No. 3 replaced on her station and Relief Light-Vessel No. 9 withdrawn May 10, 1893.

Northeast end of Five-Fathom Bank Light-Vessel No. 44, off seacoast of New Jersey.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel No. 37 May 3, 1893. Light-Vessel No. 44 replaced on her station and Relief Light-Vessel No. 37 withdrawn June 13, 1893.

Handkerchief Light-Vessel No. 4, eastern part of Nantucket Sound, Massachusetts.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel No. 9 May 10, 1893. Light-Vessel No. 4 replaced on her station and Relief Light-Vessel No. 9 withdrawn June 3, 1893.

Bush Bluff Light-Vessel No. 46, Elizabeth River, Virginia.—Withdrawn from her station to relieve Cape Charles Light-Vessel No. 49, and replaced by schooner *Drift*, June 3, 1893.

Succonnesset Shoal Light-Vessel No. 6, Nantucket Sound, Massachusetts.—Withdrawn from her station for repairs and replaced by Relief Light-Vessel No. 9 June 5, 1893. Light-Vessel No. 6 replaced on her station and Relief Light-Vessel No. 9 withdrawn June 19, 1893.

Cape Charles Light-Vessel No. 49, off entrance to Chesapeake Bay, Virginia.—Withdrawn from her station for repairs and replaced by Light-Vessel No. 46 June 7, 1893.

NEW BUOYS.

During the fiscal year the following-named special buoys were established:

White Island Ledge, Isles of Shoals, New Hampshire.—A bell buoy, July 1, 1892.

Wreck of the Alva, Pollock Rip Slue, Massachusetts.—A gas-lighted buoy, July 27, 1892.

Nantucket Sound, eastern entrance, Massachusetts.—A whistling buoy, September 30, 1892.

Mid-channel, Nantucket Sound, Massachusetts.—A bell buoy, September 30, 1892.

Wreck of the Annie S. Gaskill, off entrance to Delaware Bay, Delaware.—A whistling and a bell buoy, November 11, 1892.

Willapa Bay, outside bar, off entrance to Willapa Bay, Washington.—A whistling buoy, December 20, 1892.

Wolf Trap Shoal, Chesapeake Bay, Virginia.—A gas-lighted buoy, March 12, 1893.

Eastern Point, off Eastern Point, Massachusetts.—A whistling buoy, April 17, 1893.

Point Arena, entrance to Arena Cove, seacoast of California.—A bell buoy, May, 1893.

World's Fair buoyage, Chicago Harbor, Illinois.—Thirteen electric-lighted buoys, June, 1893.

BUOYS DISCONTINUED.

During the fiscal year the following-named special buoys were discontinued:

Mid-channel, Nantucket Sound, Massachusetts.—A whistling buoy, September 30, 1892.

Lone Rock, Deep Hole Outer Harbor (Cotuit), Massachusetts.—A bell buoy, October, 1892.

Wreck of the Florida, off Absecon Life-Saving Station, seacoast of New Jersey.—A bell buoy, December 16, 1892, the wreck having been removed.

Wreck of the Annie S. Gaskill, off entrance to Delaware Bay, Delaware.—A whistling and a bell buoy, March 11, 1893, the wreck having been removed.

Appropriations made at the second session of the Fifty-second Congress for Light-house purposes.

GENERAL.

Supplies of light-houses	$370,000
Repairs of light-houses	525,000
Salaries of light-keepers	670,000
Expenses of light-vessels	250,000
Expenses of buoyage	370,000
Expenses of fog signals	70,000
Expenses of members of Board inspecting lights, etc	2,500
Lighting rivers	300,000
Survey of light-house sites	1,000
Total	2,558,500

SPECIAL WORKS.

Brazos River light-station, Texas	50,000
Bridgeport breakwater beacon, Connecticut	2,000
Cedar Point light-station, Maryland	25,000
Chicago breakwater light-station, Illinois	15,500
Chicago Fair water front electric buoyage, Illinois	20,000
Fourteen-Mile Point light and fog signal, Michigan	20,000
Grassy Point range lights, Ohio, for moving	8,000
Grays Harbor light and fog-signal station, Washington	20,000
Hog Island light-station, Virginia	30,000
Key West light-station, Florida, additional	1,500
Marrowstone Point fog bell, Washington	3,500
Oil houses for light-stations	7,500
Rockland Lake light-station, New York	35,000
St. Catherine Sound light-station, Georgia	20,000
Seul Choix Pointe fog signal, Michigan, completion	3,300
Solomons Lump light-station, reëstablishment, Chesapeake Bay, Virginia.	30,000
Staten Island light-house depot, New York, continuing sea wall	25,000
Waackaack light-station, New Jersey, for finishing	3,200
Wolf Trap light-house, Chesapeake Bay, Virginia, reëstablishment	70,000
Total	389,500

DEFICIENCIES.

For salaries of keepers of light-houses	4.35
For expenses of fog signals	12.99
For lighting of rivers	1.25
For lighting and buoyage of rivers	25.20
Total	43.79

A detailed statement of the work done in each of the sixteen light-house districts is made in the body of the report, under specified headings, from which it will be evident that the Board has brought the numerous and varied aids to navigation under its charge up to the proper standard, and that it has done all that was possible, with the funds provided, to meet the requirements of commerce and navigation.

gate of about $1,500,000, but no appropriations were made for their construction. The following is a list of the works authorized by this act, with the maximum amount which each may cost:

Galloo Island fog signal, New York	$5,700
Carlton Island light-house, New York	8,600
Bay State Shoal lights, New York	800
Erie Harbor (Presqu'ile) fog signal, Pennsylvania	4,300
Fairport Harbor fog signal, Ohio	4,300
Lorain Harbor (Black River) fog signal, Ohio	4,300
South Bass Island light-house, Ohio	8,600
Port Clinton light, Ohio, reëstablishing	1,500
Maumee River range, Ohio, for moving	8,000
Poe Reef light-vessel, Straits of Mackinac, Mich.*	25,000
Forty-Mile Point light and fog signal, Michigan	25,000
Grand Marais light and fog signal, Michigan	15,000
Big Sable Point fog signal, Michigan	5,500
Big Bay Point light and fog signal, Michigan	25,000
Mendota light and fog signal, Michigan	7,500
Eagle Harbor fog signal, Michigan	5,500
Sand Hills light-house, Michigan	20,000
Portage Lake ship canal fog signal, Michigan	5,500
Fourteen-Mile Point light and fog signal, Michigan	20,000
Chequamegon light and fog signal, Michigan	7,500
Chequamegon Harbor light and bell	2,500
Devils Island light-station, Wisconsin, completion	22,000
Bayfield light and fog signal, Wisconsin	5,000
Pats (or Hat) Point light and fog signal, Wisconsin	15,000
Round Island light and fog signal, Straits of Mackinac, Michigan	15,00
Seul Choix Pointe light and fog signal, Michigan	5,50
South Fox Island fog signal, Michigan	5,50
North Manitou light and fog signal, Michigan	20,00
Ludington fog signal, Michigan	5,50
Ludington light and fog-signal station, Michigan, keeper's dwelling	4,50
St. Joseph fog signal, Michigan	5,00
Manitowoc fog signal, Wisconsin	5,50
Sturgeon Bay Canal light, Wisconsin	20,00
Porte des Mortes range light and fog signal, Michigan	21,00
St. Martin Island light, Michigan	15,00
Little Gull Island light and fog signal, Michigan	20,00
Squaw Point (Gladstone) light, Michigan	5,00
Peshtigo Shoal light and fog signal, Wisconsin	10,00
Sheboygan fog signal, Wisconsin	5,50
Southwest Ledge fog signal, Connecticut	12,50
Wilson Harbor light, New York	2,50
Big Oyster Bed Shoal light and fog signal, New Jersey	25,00
Salem Creek light, New Jersey	80
Mobile Bay, Alabama, additional lights along the ship channel	60,00
Deer Point light, Florida	1,00
Willamette River light and fog signal, Oregon	6,00
Grays Harbor light and fog signal, Washington	60,00
North Head light, Washington	50,00
New York Slough light and fog signal, California	10,00

*A cheaply built light-vessel has been placed on Poe Reef pending the passage of this appropri tion.

Mermentean River light, Louisiana	$7,000
Willamette River, Oregon, twenty-five beacon lights and buoys between Salem and Portland	5,000
Two-Bush Island light and fog signal, Maine	19,000
Authorized by the act approved February 6, 1893:	
Tibbetts Point fog signal, New York	4,300

LIGHTING BRIDGES.

The following recommendation, which was made in the Board's annual report for each year since 1887, is renewed:

All persons operating bridges over navigable rivers were required by the act of August 7, 1882, to maintain such lights on them as may be required by the Light-House Board for the security of navigation. The Board in due time, and after careful examination and preparation, issued a set of regulations for lighting such bridges, fully illustrated by diagrams. Persons operating such bridges have, however, obeyed these regulations only so far as they have chosen. The Board, having been unable to induce full compliance with its rules, made a test case of the most important instance of failure to comply with its regulations, and reported the matter through the proper channels to the Department of Justice for legal action. The United States attorney to whom the matter was assigned reported in effect that he could accomplish nothing by prosecution, as "the statute prescribes no penalty for its violation and gives no remedy or means for its enforcement."

The United States attorney further states:

"That it is a common-law rule that when a statute forbids or requires an act to be done, an indictment will lie against an offender if the matter involved is one of public concern, but it is a familiar principle of Federal practice that crimes and their penalties must be the subject of specific Federal legislation, and recourse to common-law principles are therefore futile. It seems to me therefore * * * that, in order to remedy the evils to safe navigation in the East River by reason of improper lights upon the Brooklyn Bridge, * * * Congress must pass an act prescribing a punishment for disobedience to the orders of the Light-House Board."

It is therefore submitted that the proper steps should be taken to obtain the suggested legislation.

NECESSARY NEW STRUCTURES.

The following recommendation, made in the Board's annual report for each year since 1887, is renewed:

For several years past the Board has included in its annual estimates of appropriations, under the head of repairs and incidental expenses of light-houses, a clause stating that the objects of the appropriations are to be considered as "including necessary new structures" (see Book of Estimates, 1888-'89, p. 203). The object of this is to sanction a practice which has prevailed since the foundation of the Light-House Establishment until quite recently, viz, the erection at established stations, as the needs of the service may require, of additional structures of small cost from the current annual appropriations. The clause in question has, however, been cut out by the Committee on Appropriations of the House of Representatives from year to year, to the great embarrassment of the service, as under such circumstances the auditing officers are of the opinion that any improvements involving a new structure can not be made, no matter how much it may be needed, or how insignificant the cost may be. This tends to defeat one of the objects for which the appropriation is made, viz, to keep the service in efficient practical working order, and to adapt it to the changing necessities of commerce. It is therefore respectfully asked that steps may be taken to urge Congress to include in the appropriation bill for the coming year the clause in question.

SUPPLIES OF LIGHT-HOUSES.

The appropriation for 1893 was $370,000, but while the appropriation was not increased over that of the previous year the number of light-stations was increased, and it is reasonable to expect that appropriations will be made during the next session of Congress for still other light-stations.

The small amount appropriated for supplies by the last Congress made it impossible for the Board to keep up its reserve stock of supplies with which to meet emergencies. This stock has been drawn upon to a large extent. It will be decreased quite largely to meet the wants created by the wholesale destruction of light-house material by the cyclones of August and October, 1893. The meagerness of preceding appropriations has made it necessary for the Board to scale down the quantity of supples furnished yearly to the light-houses to such a point that it can go no further without danger that the lights may be extinguished. The severest economy was practiced last year and is being used this year, and as the number of lights has increased it is feared that the present lights and those which are being built can not be kept up from the current appropriation. The passage of the eight-hour law will enhance the price of all manufactured material used to supply light-houses, but to what amount the Board is not as yet able to determine. The Board therefore estimates that $410,000 will be needed for the fiscal year to end on June 30, 1895.

SALARIES OF LIGHT-HOUSE KEEPERS.

Last year Congress appropriated $670,000 to pay the salaries of not exceeding 1,250 keepers. But 1,139 keepers were employed. In quite a number of instances the Board found itself unable to provide keepers for needed beacon lights which it had funds to build, and hence these lights are not yet established.

The statement made in the Board's last annual report in reference to this subject, is repeated:

> It has become necessary, in view of the great pressure on this appropriation, to temporarily omit filling certain vacancies as they occurred, where there was more than one keeper at a station. This has necessarily resulted in inferior service on the part of the overworked keepers remaining at those stations. Two men can not do the work of three properly for any extended term.
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> The duties of light-keepers have been greatly increased by the addition of steam fog-signal apparatus, requiring, in many cases, the attention of steam engineers. It has been found that it is impossible to obtain the services of men for many of these positions, for the pay offered, who hold certificates that they have passed examinations as steam engineers. Hence the Board has been unable to get the best results from its steam fog signals. The steam is not raised as soon as it might be so as to get the fog signal to sounding as soon as it should. The machinery gets out of order sooner than it would if in the charge of a skilled engineer. It remains out of use until a machinist is sent from a distant town at large expense in wages and transportation to fix it, and the life of the machine is much shorter than it would

be if in the charge of a certificated engineer. It is poor economy to stint the pay of engineers to such point that the services of only the poorest can be commanded, as it costs so much to remedy the mistakes they unavoidably make.

It has been found in practice that it is difficult to retain in the service men of sufficient experience and ability to operate and take the proper care of the delicate, complicated, and expensive illuminating apparatus placed in their charge. Hence it costs more than it formerly did, and more than it ought, to keep this apparatus in running order. The Board therefore suggests that it would be better, from an economical point of view, to raise the average salary of the light-keeper to the amount fixed by law rather than to maintain it at its present rate, and especially to decrease it still more. But to supply light-keepers of the present grade of ability in sufficient numbers to man the light-houses built and to be built within the coming fiscal year will require an appropriation of $680,000.

The Board anxiously feels the difficulty with which it retains its trained and experienced light-keepers. The pay they receive is insufficient to induce them to remain in the service. During the four years between March 4, 1885, and March 4, 1889, 769 persons entered the service by original appointment. During the four years which elapsed between March 4, 1889, and March 4, 1893, 672 persons received original appointments into the Light-House Service. Each of these appointments was made to fill a vacancy made by cause. These causes were death, resignation, or removal. Each removal was made for specified written and recorded cause, and never for political reasons. The removals number, say, one in seven of all the vacancies. The vacancies caused by death are inconsiderable in number. The vacancies caused by resignation are, say, between five and six out of every seven. There were, on an average, say, 1,190 light-keepers in the service during each of the last past four years, about 170 of whom vacated their places each year, and of that number there were perhaps 120 who resigned mainly because they could better their condition by so doing. It is, however, estimated that $680,000 will be needed on the present basis for salaries of light-house keepers during the next fiscal year.

EXPENSES OF LIGHT-VESSELS.

Last year an appropriation of $250,000 was made to defray the expenses of light-vessels for this fiscal year. Since then light-ships have been built and established at Bar Point Shoal, entrance to Detroit River, Lake Erie; Eleven-Foot Shoal, in Green Bay, Lake Michigan; Poe Reef, in the Straits of Mackinac, at the junction of three great lakes; at the lower end of Lake Huron; at Ballards Reef and at each of the two ends of Limekiln Crossing, in Detroit River, all of which are new stations. In addition to these, first-class light-vessels have been built and substituted for old ones at New South Shoals in the Atlantic Ocean, 30 miles south of Nantucket, Mass.; off Cornfield Point, Conn., in Long Island Sound; at Fenwick Island Shoal, in the Atlantic Ocean off the coast of Maryland, and at Frying-Pan Shoal, in the Atlantic Ocean off the coast of North Carolina. Each new ship has a steam fog signal, and the Cornfield Point light-vessel has also an elec-

tric plant, which enables her to show an electric light. These improvements make the new ships vastly more useful than were the old ones, and the cost of their maintenance is much greater.

The past year was quite severe on all light-ships and made them as a whole more costly to maintain. All suffered from the extreme weather, but some suffered more than others. One light-vessel, No. 37, then on Five-Fathom Bank, in the Atlantic Ocean off Cape May, N. J., foundered not far from her moorings, and was practically destroyed by the cyclone of August 23, 1893, when four out of the six men on board were lost. Another light-vessel, the one then on Rattlesnake Shoals, Atlantic Ocean, off Charleston, S. C., was torn from her moorings and driven ashore. Her crew were saved and it is hoped that the vessel may be hauled off from the beach. Contract has been made with a wrecking company to get her off and tow her to Charleston, for $5,500. What it will cost to repair and refit her has not yet been ascertained.

In view of the extra expenses to be incurred in repairing damages done to the old light-vessels by the unusual storms, and of the establishment of four new and improved light-vessels to take the places of old ones, and the establishment of seven new light-vessels upon new light-stations, the Board estimates that the expenses of light-vessels for the ensuing fiscal year will be $300,000, and recommends that this amount be appropriated therefor.

EXPENSES OF BUOYAGE.

On March 3, 1893, Congress appropriated $370,000 for the expenses of the 4,469 buoys of all kinds then in place. The terrible cyclones of August, which did so much damage to the buoyage of the Atlantic coast, were rivaled by hurricanes of October which ravaged the Gulf coast. The Board hopes to get through the fiscal year without asking for a deficiency appropriation; but if it does it will be at the expense of its reserve stock of buoys and appurtenances. It will, therefore, need a much larger appropriation than usual, not only to meet the immediate wants of commerce, but to bring up its stock of reserve buoys to its normal condition. The Board has been forced to decline many requests for placing new buoys during the past year, not because in its opinion they were not needed, but because there were not sufficient funds at its disposal to increase and maintain a larger number of buoys than those already in position. It is therefore recommended that $450,000 be appropriated for expenses of buoyage for the year to end on June 30, 1895.

LIGHTING OF RIVERS.

The great good, at such comparative small cost, which has been done to the steamboat traffic on the Western rivers has perhaps created a demand that certain Eastern rivers should be lighted in the

same inexpensive way. The Board has, however, been unable to meet this just demand because it is without funds with which to extend this method of lighting rivers. The appropriation made last year was barely sufficient to maintain the lights previously established. The Board estimates that it will cost $350,000 to properly light the rivers of the country next year.

ELECTRIC LIGHTS FOR LIGHT-SHIPS.

Last year the new light-vessel placed on the Cornfield Point station in Long Island Sound, Connecticut, was fitted with a plant which has enabled it to show electric flashing lights. The experiment has proved to be a physical success. It has, however, cost more to maintain this vessel than is desirable. Efforts are now being made to reorganize and simplify the machinery in the interests of economy. Attention is invited to the report of Capt. W. S. Schley, U. S. Navy, inspector of the Third Light-House District, as to the operations of the electric light on the Cornfield Point light-vessel. It will be found in an appendix to this volume.

REVOLVING LIGHTS FOR LIGHT-SHIPS.

The method by which revolving lights were fitted to and operated on the new light-ship placed off Sandy Hook, New York Bay, and on its relief light-ship, No. 16, was described in the Board's last annual report. An account of the results of this experiment in United States waters is given in the report by Capt. W. S. Schley, U. S. Navy, inspector of the Third Light-House District, which can be found in an appendix at the end of this volume.

TECHNICAL BOOKS FOR THE LIGHT-HOUSE ESTABLISHMENT.

The following recommendation, which was made in the Board's last two annual reports, is renewed:

> From the organization of the Light-House Establishment until quite recently it has been the practice of the Board to buy such technical and professional books and periodicals as were needed, and to pay for them from the proper general appropriations. This course was taken with the permission of the Secretary of the Treasury, given in many cases previously in writing, and with the approbation of the accounting officers of the Department, as shown by their approval of the accounts rendered therefor by the purchasing officer of the Board. These purchases are now disallowed by the accounting officers.
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> It has been from the beginning the settled and authorized policy of the Board to maintain a technical library to aid its constructing officers in the performance of their duties. This library now contains more than 3,000 volumes, many costly, most of them rare, and some of them unique, at least in this country. This was found to be the case during the session of the International Marine Conference, when books were borrowed from this library for its use on the plea that they could not be found elsewhere.
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> Books bought to enable the Board to build a certain light-house or light-ship might be charged against the appropriation for building that structure; but such

books, while bought to meet the needs of the Board in each case, are kept to meet all similar cases arising afterwards. Hence they should be paid for from the general rather than from special appropriations. Books thus obtained are placed in the Board's library, which is a lending library, open to all the engineers and inspectors of the sixteen light-house districts. By this method a book bought for one district officer is open to the use of all. This prevents duplication of books and saves much expense.

The Board, in order to keep abreast of the march of science in the highly scientific work for which it is responsible, has great need and makes large use of its library.

An appropriation of $300 was made for this purpose last year, and it is recommended that the same amount be appropriated for the purpose for use during the coming year.

INSPECTING LIGHTS.

The Light-House Board consists of nine persons. Each member is supposed to be an expert in some branch of pharology, and for that reason he is detailed to this duty. His value to the service increases as he comes in personal contact with the local light officers while in performance of their duty, and this can be accomplished only by actual journeys to the various districts. The theory is that light-house inspectors and engineers inspect the light-houses, light-ships, light-house and buoy depots, and their appurtenances, and that the members of the Light-House Board inspect the work of the inspectors and engineers. In proportion as this theory is carried into effect uniformity and precision of action is insured. Proper inspection by members of the Board is, however, limited by the fact that their mileage, or traveling expenses, can be paid only from the $3,000 appropriation made yearly for inspecting lights. Small as this appropriation is, it is burdened by the provision that from it must be paid the rewards offered for information as to collisions and for the apprehension of those who have damaged light-house property. It is therefore recommended that this amount be increased to $5,000 for the coming year, or that the Board be authorized to pay its members' mileage or traveling expenses from the several general and special appropriations to which the travel may pertain.

TELEPHONIC COMMUNICATION BETWEEN LIGHT-SHIPS AND SHORE.

There was referred from the Committee on Interstate and Foreign Commerce of the House of Representatives, through the proper channels to this office for suggestion as to the propriety of its passage, House bill No. 37, which appropriates $150,000 to provide and maintain communication by telephone, telegraph, or otherwise with light-ships, light-houses, and life-saving stations on the coast, to secure prompt information of vessels in distress, and authorizing experiments to determine the most effective means for so doing. The Board replied, making urgent recommendation that the bill be enacted.

It is proposed by the Light-House Board, if funds are provided for the purpose, to first make electric connection between a light-house on a telegraphic shore line and an important light-ship, which, while it is near the shore, is at a point where it is passed close-to by many vessels. These conditions would be met by connecting Monomoy Point light-house, Mass., with Pollock Rip light-ship, which are some 4 miles apart. Having done this the Board proposes next to connect two such stations much farther apart where the conditions of the bottom, current, and approaches are different. This could be done by laying a cable between Sandy Hook light-ship New York, and the Hook Beacon, on Sandy Hook, which are some 8 miles apart. It is then proposed to lay a cable between a light-ship and a light-house at a much greater distance apart, and on another part of the coast. A cable run between Winter-Quarter Shoal light-ship and Assateague light-house, Virginia, some 11 miles distant, would accomplish this. Then a cable might be run, say from Frying-Pan Shoal light-ship some 18 miles to Cape Fear light-house, North Carolina. This might be followed by a cable run from Five-Fathom Bank light-ship to Cape Henlopen light-house, Delaware, some 23 miles off. And this could be followed by laying a cable from Sankaty Head light-house, on the island of Nantucket, Massachusetts, to Nantucket New South Shoals light-ship, some 30 miles south and straight out into the Atlantic Ocean. This light-ship is the most distant from our coast of any in the service. It is in the track of all coasting vessels going outside of Nantucket from the north to the south and back, and of vessels going to and from Europe. It is an exceedingly important post and would be of immense value to commerce if communication could be had between that light-ship and the commercial centers.

The Light-House Board for several years has promoted experiments looking to obtaining electric communications between light-ships and shore. It has watched, with great care, the experiments made by other maritime countries, and it has noted the difficulties with which they have contended.

The Board is now under the impression that the experiments recently made at its instance have developed a method by which the electric difficulties met by other light-house establishments may be overcome. And the Board believes that, if furnished with proper funds, it can make and maintain electric communication between its light ships and the shore stations. But as this is new work the Board prefers to take one step at a time and utilize the experience thus gained in making the next step, going from the nearer to the farther by degrees, until the most distant and important light-ship is reached and the most difficult and expensive work is done.

As the Board has not been supplied with funds for making practical experiments all that it has been able to do in this line is to promote the making of experiments in the laboratory at the dock and, in one

instance, in connection with a relief light-ship anchored a short distance from the light-house depot where she belonged. Even this strained the resources of the establishment, and they had to be supplemented by private means. Still, the results attained were such that the Board is now prepared to test, in actual practice, the plans formed after successful laboratory and dock experiments.

The views of the Board were asked last year as to the passage of a somewhat similar bill appropriating $50,000 for, in effect, making experiments for this purpose. Favorable reply was made, and, in consequence, the amount named in that bill, $50,000, appears in the Board's annual estimates. It is understood that the amount named in House bill No. 37 is not only for experimentation, but for actually putting the result of the experiment to practical test.

The amount, $150,000, named in the House bill No. 37 is none too much to purchase the material and plant and to pay for the labor and scientific supervision needed to do the work proposed.

GAS BUOYS.

The following recommendation which was made in the Board's annual report last year is renewed:

The buoy used is of the Pintsch pattern and patent. It is forged by a secret process without seam and holds compressed gas without perceptible loss, which burns with a steady flame and which is rarely extinguished from any cause, making a useful light. The gas buoy is sometimes used to replace, temporarily, a light-ship while the latter is under repair. It is sometimes used where a light-ship can not be moored. A dangerous wreck in an important channel leading into New York had to be marked, and as the channel was too narrow to admit of a light-ship being placed near the wreck a Pintsch gas buoy was used there satisfactorily, to the great advantage of shipping, for a considerable length of time and until the wreck had disappeared. The Board in 1891 placed a lighted gas buoy in the fairway of vessels going north and south near to the wrecks of the steamer *Vizcaya* and the schooner *Hargraves*, off Barnegat light, on the New Jersey seacoast, where it served to keep vessels from running on to these wrecks. In the summer of 1892 it placed a gas buoy in Pollock Rip Slue, Massachusetts, off the wreck of the yacht *Alva*, which was also in the fairway of vessels going north and south. A gas buoy was also placed so as to mark a wreck in Boston Harbor, and the buoy was kept there until the wreck was broken up and disappeared.

By the act approved on March 3, 1891, $30,000 was appropriated for gas buoys, but the Board was limited to the payment of not exceeding $2,000 each. This provision precluded the purchase of many of the larger class. The buoy which the Board has used so successfully for the past six or seven years weighs about 6,000 pounds and costs about $2,000 on the other side of the Atlantic, where only it is made. The duty upon it is about 45 per cent ad valorem. That amount, with the freight, would make each buoy of the size most wanted cost about $3,000 delivered at the general light-house depot.

As the Board was not able to get the buoys most needed the amount was expended in the purchase of a small class of buoys, which can be used in the stiller waters of the sounds and lakes. Ten more gas buoys of the large sizes are needed.

The Board estimates that they will cost $30,000, and it is recommended that an appropriation of this amount be made for that purpose.

NEW LIGHT-SHIPS.

During the fiscal year which ended on June 30, 1892, the Board built and placed in position, as was detailed in the annual report for that year, five first-class light-vessels, each with steam motive power and each with a powerful fog signal. During the last fiscal year the Board built and has recently placed in position seven small, inexpensive lake and river light-vessels only intended for temporary service. But they were the best that could be built with the funds appropriated for the purpose. It is hoped that they may be made to last until other and more substantial aids to navigation are provided to take their places. The light-vessel now at Bar Point Shoal, mouth of Detroit River, Lake Erie, the vessel at the foot of Lake Huron, the vessel near Poe Reef, in the Straits of Mackinac, and the vessel near Eleven-Foot Shoal, in Green Bay, Lake Michigan, were built on the same lines. They are called light-ships Nos. 59, 60, 61, and 62. Each is 80 feet long, 21 feet 6 inches beam, and 9 feet 5 inches hold. Each has a steam fog signal of a new and improved pattern, by which it is claimed that steam can be gotten up and the signal sounded within less than half the time now used on any other light-vessel. The light-vessel at Bar Point Shoal was built from an appropriation of $25,000 made therefor by the act approved on August 5, 1892; the other three were built from the appropriation of $60,000 made by the act approved August 30, 1890, for building a light-house on Eleven-Foot Shoal, but which the Board was authorized by act of August 5, 1892, to use in building "one or more light-vessels." The Board had hoped to build four of these small, cheap vessels from this appropriation, that one might be placed on Peshtigo Shoal, Green Bay, Lake Michigan, but it was found when the bids advertised for were opened that but three of even such vessels could be built and outfitted for that amount. There is, however, a bill now pending appropriating $25,000 to establish a light-vessel on Poe Reef. The establishment of this light-vessel was authorized by the act approved on February 14, 1893. If the appropriation thus called for is made at an early day the vessel that is built with it can be placed at Poe Reef and the light-vessel now there can be transferred to Peshtigo Shoal, where it is much needed.

The light-vessel now at Ballards Reef and the two vessels marking each end of the Limekiln Crossing, in Detroit River, were built and outfitted from the appropriation of $8,600 made by the act approved August 5, 1892, for Detroit River light-vessels. They are mere scows, being nearly as wide at the ends as they are amidships, measuring 42 feet in length, 13 feet 7 inches in breadth, and 3 feet 8 inches deep. Each has a trunk cabin, shows its light from a tripod, and has a crew of two men. They replace private light-vessels of much the same size, shape, and cost. It is hoped that they may be made to last until they

can be replaced by vessels better fitted for the purpose and approaching more nearly to the standard of the Light-House Establishment.

An appropriation of $70,000 was made by the act approved on August 5, 1892, for building a light-vessel to be placed on Nantucket New South Shoals, a position some 30 miles south of the island of Nantucket and directly out into the Atlantic Ocean. This is by far the most exposed, difficult, and dangerous place that is occupied by any light-vessel in the Light-House Service. The vessel now there is one of the best in the service, but she met with so narrow an escape from foundering at her moorings during the heaviest storm of last winter that the Board deemed it best to design a vessel for that especial position. This was done, and the contract to build the vessel from the new plans was given to the lowest bidder. The new vessel will have sufficient steam power to get to and from her station with her own propeller. She will have a powerful fog signal, and she will be, it is expected, the best light-vessel ever built for the Light-House Service. She is to be on her station early next year. Her length over all will be 121 feet 10 inches, her breadth 28 feet 6 inches, and her depth 13 feet.

THE NEW LIGHT-HOUSE TENDER.

The new steam tender *Maple*, built for use in the Fifth Light-House District, and described in the Board's last annual report, which was to have been completed under contract in December last, was not fully completed and entirely accepted until June. The contractor incurred a heavy penalty by this delay, which can only be remitted, under the wording of the contract, by act of Congress. The new tender was put to work immediately upon her acceptance.

The new steam tender *Columbine* which, as was stated in the last annual report, sailed from New York City for the Pacific coast on October 30, 1892, arrived at San Francisco on January 29, 1893. This voyage was made under the command of Lieut. Commander C. H. West, U. S. Navy, in very good time, and the vessel arrived out in fairly good condition. After receiving needed repairs and being fitted for her especial work at San Francisco she was taken to Portland, Oregon, and turned over to the inspector of the Thirteenth Light-House District, under whom she is now doing very good work.

ELECTRIC-LIGHTED BUOYS.

An account of the electric-buoy plant in New York Bay, and also of that on the Chicago and World's Fair water front, is given by Lieut. Commander C. H. West, U. S. Navy, assistant to the inspector of the Third Light-House District, in an appendix to this volume.

In another appendix by Commander J. J. Brice, U. S. Navy, inspector of the Ninth Light-House District, will be found an account of the action of electric buoys on the World's Fair water front.

PERSONNEL.

The following changes have taken place in the personnel of the Light-House Board since the date of the last annual report:

Hon. John G. Carlisle, Secretary of the Treasury, succeeded Hon. Charles Foster, Secretary of the Treasury, as *ex officio* president of the Board, March 4, 1893.

On November 30, 1892, Commander George W. Coffin, U. S. Navy, naval secretary, was relieved by Commander Robley D. Evans, U. S. Navy.

On April 11, 1893, Col. Oswald H. Ernst, Corps of Engineers, U. S. Army, was relieved by Col. John M. Wilson, Corps of Engineers, U. S. Army.

On May 14, 1893, Commodore James H. Gillis, U. S. Navy, was retired, and was succeeded by Capt. George Dewey, U. S. Navy, May 15, 1893.

On June 3, 1893, Lieut. Col. George H. Elliot, Corps of Engineers, U. S. Army, was relieved at his own request, and was succeeded by Maj. Henry M. Adams, Corps of Engineers, U. S. Army.

ESTIMATES FOR GENERAL APPROPRIATIONS.

Supplies of light-houses	$110,000
Repairs of light-houses	750,000
Salaries of keepers of light-houses	680,000
Expenses of light-vessels	300,000
Expenses of buoyage	450,000
Expenses of fog signals	125,000
Inspecting lights	5,000
Lighting of rivers	350,000
Survey of light-house sites	1,000

ESTIMATES FOR SPECIAL APPROPRIATIONS.

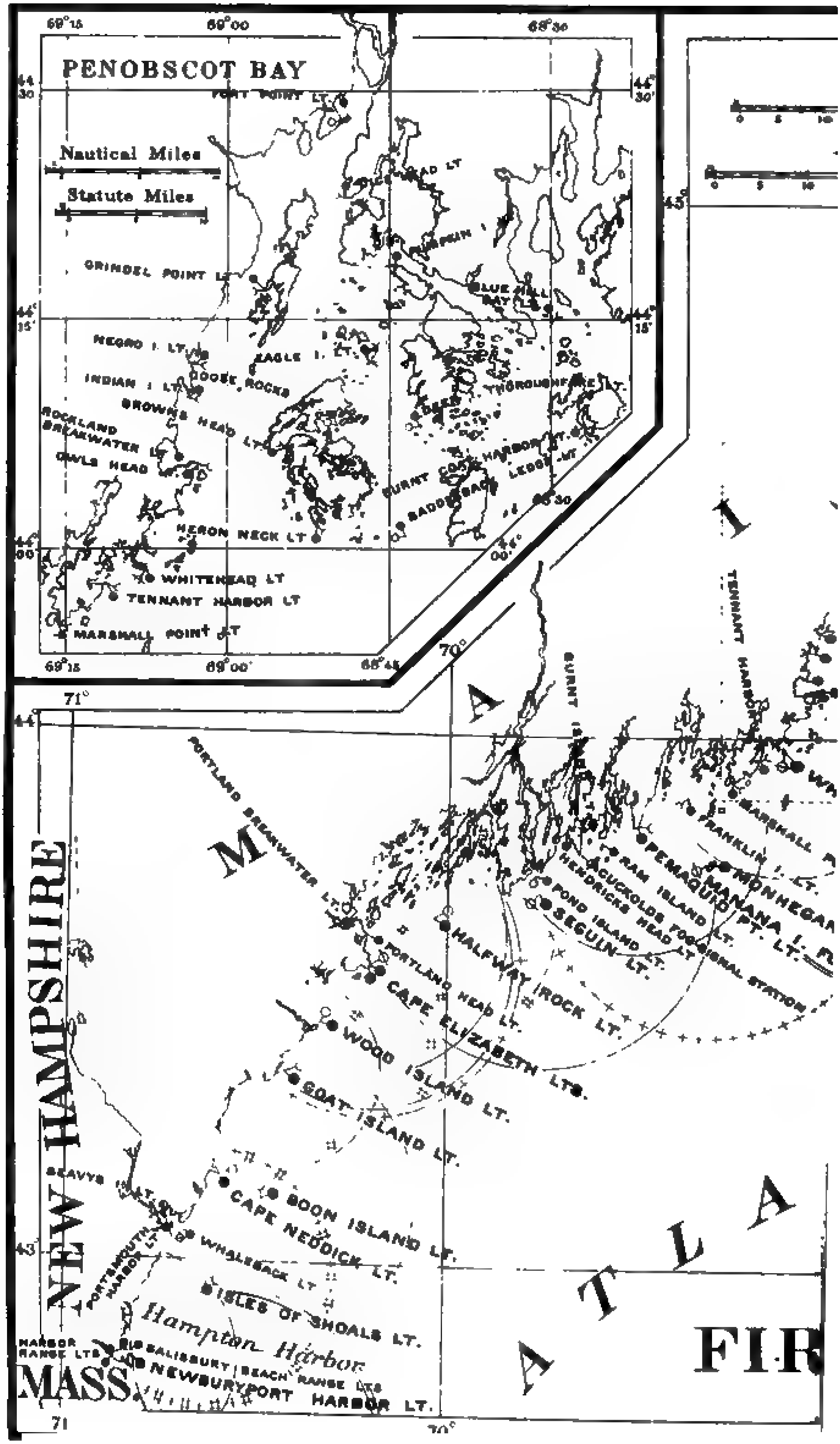
Absecon buoy depot, New Jersey, completion, etc	2,000
Alligator River light and fog signal, North Carolina	20,000
Ames Ledge light-station, Kennebec River, Maine	75
Ballards Reef light and fog-signal station, Michigan	100,000
Baltimore light and fog-signal station, Maryland	60,000
Bayfield light-station, Lake Superior, Wisconsin	5,000
Bay State Shoal and Oak Point Shoal, Lake Ontario, New York, temporary floating lights	800
Beaufort Harbor range lights, North Carolina	10,000
Big Bay Point light and fog-signal station, Michigan	25,000
Big Oyster Beds light and fog-signal station, New Jersey	25,000
Big Sable fog signal, Lake Superior, Michigan	5,500
Black Ledge light and fog signal station, Connecticut	45,000
Black River or Lorain steam fog signal, Lake Erie, Ohio	4,300
Bodega Head light and fogsignal station, California	30,000
Boon Island, keeper's dwelling, Maine	3,400
Boston Harbor light-ship, Massachusetts	70,000
Bridgeport light-station, Connecticut, completing work on beacon	2,500
Butler Flat light and fog-signal station, Massachusetts	45,000

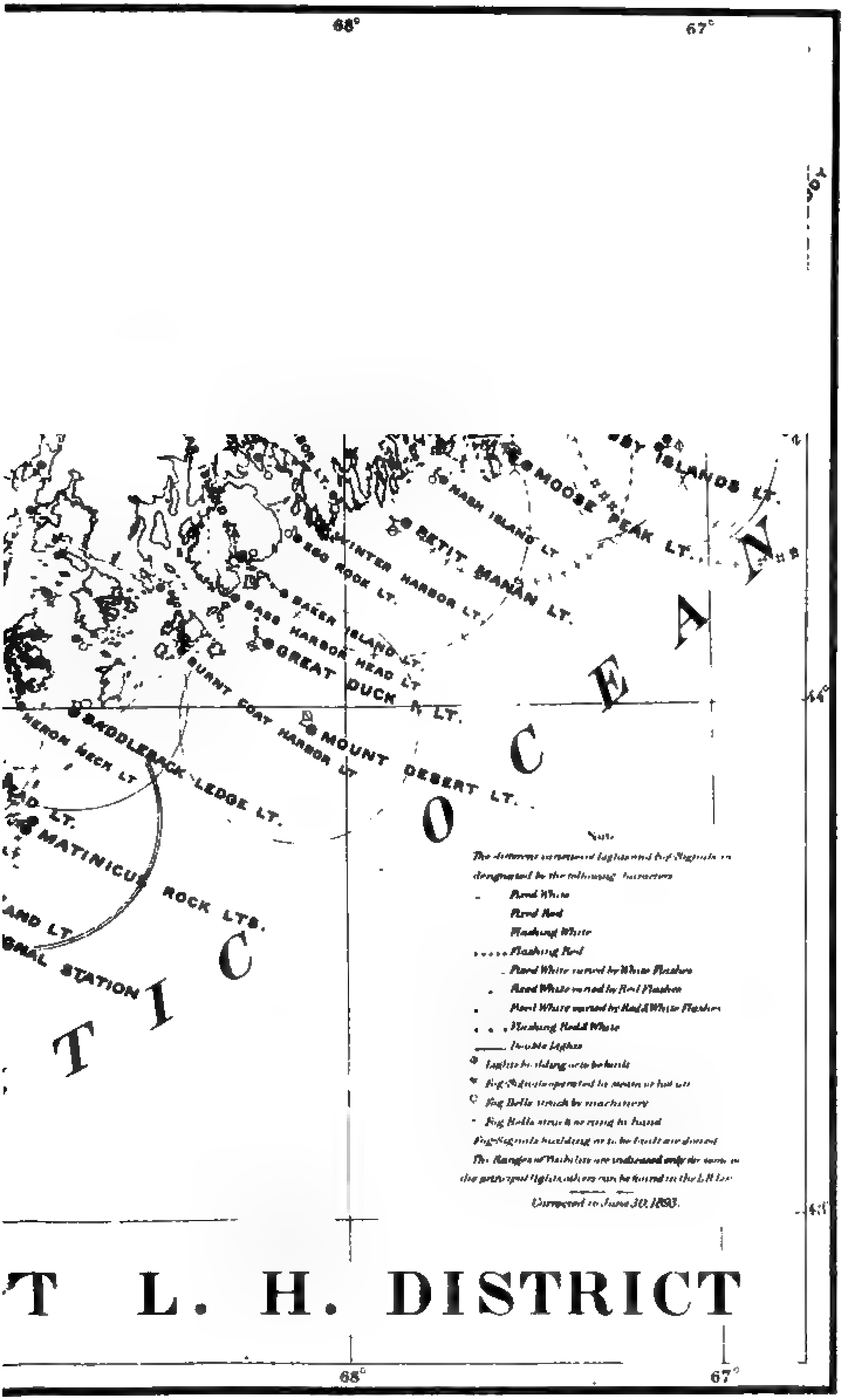
Cape Arago light-station, Oregon	(*)
Cape Elizabeth, keeper's dwelling, Maine	$3,300
Cape Fear light-station, North Carolina	70,000
Cape Fear River range lights, North Carolina	3,105
Cape Flattery fog signal, Washington (new site)	17,000
Cape Lookout Shoals light-ship, North Carolina	70,000
Cape May boathouse, New Jersey	800
Cape Mendocino light-station, California (roadway)	500
Carlton Island light-station, Lake Ontario, New York	8,600
Cheboygan River front range light, Straits of Mackinac, Michigan (additional land)	1,750
Chequamegon Point light and fog signal, Lake Superior, Wisconsin, moving and rebuilding La Pointe main light and establishing harbor bell and light	10,000
Clark Ledge light and fog-signal station, Maine	30,000
Cleveland light-station, Ohio (new site), keeper's dwelling and storehouse	25,000
Deadman Island light and fog signal, San Pedro Harbor, California	5,000
Deer Point light-station, Pensacola Bay, Florida	1,000
Depot for ninth and eleventh light-house districts, Scammons Harbor, Michigan	15,000
Depot for sixth light-house district, at or near Charleston, South Carolina	155,000
Detroit light-house depot, Michigan, paving Mount Elliot avenue	2,000
Devils Island, Apostle Group, Lake Superior, Wisconsin, permanent tower	22,000
Doboy Sound range lights, Georgia	1,500
Dog River Bar light-station, Alabama	20,000
Doller Point range lights, James River, Virginia	2,500
Doubling Point light and fog-signal station, Kennebec River, Maine	6,300
Eagle Harbor fog signal, Lake Superior, Michigan	5,500
Eagle River light-station, Lake Superior, Michigan, moving light to Sand Hills	20,000
Egmont Key, Florida, keeper's dwelling	4,000
Electric communication with light-vessels	50,000
Escanaba fog signal, Lake Michigan, Michigan	1,100
Fairport fog signal, Lake Erie, Ohio	4,700
Fort Wadsworth light and fog-signal station, New York, moving from Fort Tompkins	1,500
Forty-Mile Point light and fog-signal station, Lake Huron, Michigan	25,000
Galloo Island fog signal, Lake Ontario, New York	5,700
Gas buoys	30,000
Gladstone light-station, Lake Michigan, Michigan	10,000
Grand Marais light-station, Minnesota, to apply unexpended balance of appropriation to purchase of site for and construction of dwelling, $8,409.17	(*)
Grand Marais light and fog signal, Lake Superior, Michigan	15,000
Grassy Island, range lights above, Detroit River, Michigan	1,500
Grassy Island north range, Detroit River, Michigan	5,500
Grassy Island south range, Detroit River, Michigan	700
Grassy Point range, Ohio, moving lights	2,000
Grays Harbor light and fog-signal station, Washington, completing	39,500
Green Island light-station, Maine	12,000
Grosse Isle range light-station, Detroit River, Michigan, keeper's dwelling	5,000
Hat (or Pats) Point light and fog signal, Lake Superior, Minnesota	15,000
Heron Neck, keeper's dwelling, Maine	3,300
Hillsboro Inlet light-station, Florida	90,000
Hog Island Shoal light-ship, Rhode Island	70,000

*Authority.

Hog Island light-station, Virginia, completion	$95,000
Inside Passage beacon lights, Georgia and Florida	4,000
Kewaunee fog signal, Lake Michigan, Wisconsin	5,500
Lazaretto Point light-house depot, Maryland, keeper's dwelling	2,500
Libby Islands, keeper's dwelling, Maine	6,200
Little Gull Island light and fog-signal station, Lake Michigan, Michigan.	20,000
Little River fog-signal station, Maine	10,500
Ludington Pierhead light and fog-signal station, Lake Michigan, Michigan, keeper's dwelling	4,500
Manistique light and fog-signal station, Lake Michigan, Michigan	32,000
Manitowoc fog signal, Lake Michigan, Michigan	5,500
Marblehead, Massachusetts, new tower	45,000
Mary Island beacon light, Alaska	800
Matinicus Rock, keeper's dwelling, Maine	3,200
Maumee Bay range light-station, Ohio, new beacons and dwelling	15,000
Menasha range lights, Wisconsin	500
Mendota light-station, reëstablishment, Lake Superior, Michigan	7,500
Mermenteau River light-station, Louisiana	7,000
Mobile ship channel lights, Alabama	60,000
Mount Cornelia light-station, Florida	125,000
New York Slough light and fog-signal station, California	10,000
North Head, Cape Disappointment light-station, Washington	50,000
North Manitou light and fog-signal station, Lake Michigan, Michigan	20,000
Oil houses	15,000
Old Mackinac Point light-station, Straits of Mackinac, Michigan, additional land	1,000
Oswego Breakwater fog signal, Lake Ontario, New York	4,300
Pere Marquette fog signal, Lake Michigan, Michigan	5,500
Perkins Island light-station, Kennebec River, Maine	5,700
Peshtigo Shoal light and fog-signal station, Wisconsin	10,000
Plum Beach light and fog-signal station, Rhode Island	60,000
Poe Reef light-ship, Straits of Mackinac, Michigan	25,000
Point Arguello light and fog-signal station, California	35,000
Point Buchon light and fog-signal station, California	33,000
Point Hueneme light-station, California, additional land	3,000
Point No Point light-station, Chesapeake Bay, Maryland	35,000
Point Pinos light-station, California, additional land	2,000
Pork Point light and fog-signal station, North Carolina	20,000
Portage Lake light-station, Lake Michigan, Michigan, keeper's dwelling	3,500
Portage Lake Ship Canal pierhead fog signal, Lake Superior, Michigan	5,500
Port Clinton light-station, Lake Erie, Ohio, reëstablishing	1,500
Porte des Morts range lights and fog-signal station, Lake Michigan, Michigan	21,000
Portsmouth light-house depot, Virginia, repairs to buildings and extending wharf	40,000
Presqu'ile Pierhead fog signal, Erie Harbor, Lake Erie, Pennsylvania	4,300
Punta Gorda light and fog-signal station, California	40,000
Quarry Point fog-signal station, San Francisco Bay, California	6,000
Rappahannock River, Va., additional lights	3,300
Round Island, North Passage, Mission Point, Mackinac Island, Lake Huron, Michigan	15,000
Salem Creek light-station, New Jersey	800
Sandusky Bay range light-station, Ohio, moving and rebuilding keeper's dwelling	25,000
St. Joseph Pierhead fog signal, Lake Michigan, Michigan	5,000

Point light-station, Florida	$25,000
Island light and fog-signal station, Green Bay, Michigan	15,000
Pointe light-station, Michigan—completing structures	5,000
Pointe fog-signal station, Lake Michigan, Michigan	2,200
Pierhead fog signal, Wisconsin	5,500
larbor light-station, Connecticut	10,000
Island light-station, Lake Erie, Ohio	8,600
on range lights, Boston Harbor, Massachusetts	1,000
Island fog signal, Lake Michigan, Michigan	5,500
raukee light-station, Wisconsin	7,500
sland range lights, Boston Harbor, Massachusetts	9,350
nt Ledge light and fog-signal station, Portland Harbor, Maine	45,000
int light-station, Kennebec River, Maine	4,650
nd light-house depot, New York, sea wall, etc	75,000
e light and fog-signal station, Massachusetts	42,000
iberty light-station, New York Harbor, New York, completing	50,000
ay Canal light-station, Lake Michigan, Wisconsin	20,000
ierhead fog signal, Wisconsin	5,500
t Bar light and fog-signal station, Maryland	50,000
the third light-house district	95,000
oint fog signal, Lake Ontario, New York	4,300
Island light and fog signal, Penobscot Bay, Maine	19,000
eef light-ship, Straits of Fuca, Washington	80,000
iver light-station, Oregon, completion	2,371
og-signal station, Rhode Island	5,000
River light and fog-signal station, Oregon	6,000
River post lights, Oregon	5,000
rbor light-station, Lake Ontario, New York	2,500
nt light-station, North Carolina	5,000
ay lights, Oregon	300


PENOBSCOT BAY
Nautical Miles
Statute Miles
FORT POINT LT
GRINDEL POINT LT
NEGRO I. LT
EAGLE I. LT
GOOSE ROCKS
INDIAN I. LT
BROWNS HEAD LT
ROCKLAND BREAKWATER LT
OWLS HEAD LT
BLUE HILL BAY LT
THOROUGHFARE LT
BURNT COAT HARBOR LT
SADDLEBACK LEDGE LT
HERON NECK LT
WHITEHEAD LT
TENNANT HARBOR LT
MARSHALL POINT LT
NEW HAMPSHIRE
MASS
PORTLAND BREAKWATER LT
PORTLAND HEAD LT
CAPE ELIZABETH LTS
HALFWAY ROCK LT
WOOD ISLAND LT
GOAT ISLAND LT
BOON ISLAND LT
CAPE NEDDICK LT
WHALEBACK LT
ISLES OF SHOALS LT
PORTSMOUTH HARBOR LT
Hampton Harbor
SALISBURY BEACH RANGE LTS
HARBOR RANGE LTS
NEWBURYPORT HARBOR LT
SEGUIN LT
POND ISLAND LT
HENDRICKS HEAD LT
CUCKOLDS FOG SIGNAL STATION
RAM ISLAND LT
PEMAQUID PT. LT
FRANKLIN I. LT
MANANA I.
MONHEGAN
MARSHALL P
TENNANT HARBOR
BURNT
M
A
ATLA
FIR



68°
67°
MOOSE PEAK LT.
ISLANDS LT.
NASH ISLAND LT.
PETIT MANAN LT.
WINTER HARBOR LT.
EGG ROCK LT.
BAKER ISLAND LT.
BASS HARBOR HEAD LT.
GREAT DUCK I. LT.
BURNT COAT HARBOR LT.
MOUNT DESERT LT.
SADDLEBACK LEDGE LT.
HERON NECK LT.
MATINICUS ROCK LTS.
SIGNAL STATION
A T L A N T I C O C E A N
Note
Fixed White
Fixed Red
Flashing White
Flashing Red
Corrected to June 30, 1893.
T L. H. DISTRICT

FIRST DISTRICT.

The first district extends from the head of navigation in the St. Croix River, Maine, the eastern boundary of the United States, to and including Hampton Harbor, New Hampshire, and includes all the aids to navigation on the coasts and in the navigable bays, rivers, and inlets of Maine and New Hampshire.

Inspector.—Commander Frank Wildes, U. S. Navy, to September 15, 1892; Commander Merrill Miller, U. S. Navy, to April 1, 1893; Commander George E. Wingate, U. S. Navy, from April 1, 1893.

Engineer.—Maj. William R. Livermore, Corps of Engineers, U. S. Army.

In this district there are—

Light-houses and beacon lights	63
Day or unlighted beacons	103
Fog signals operated by steam or hot-air engines	13
Fog signals operated by clockwork	17
Whistling buoys in position	11
Bell buoys in position	16
Other buoys in position	619
Steamer *Lilac*, buoy tender, and for supply and inspection	1
Steamer *Myrtle* for construction and repair in the first and second districts	1

The number preceding the name of a light-station is that by which it is designated in the list of lights and fog signals on the Atlantic and Gulf coasts of the United States, corrected to January 1, 1893, or in the list of lights and fog signals on the Pacific coast of the United States, corrected to January 1, 1893, or in the list of lights and fog signals of the United States on the Northern lakes and rivers, corrected to the opening of navigation, 1893.

LIGHT-HOUSES.

1. *Whitlocks Mill, at edge of south bank of St. Croix River, Maine.*—A red lantern light was displayed from a tree from July 15, 1892.

—. *Clark Ledge, St. Croix River, near Eastport, Maine.*—The following recommendation, made in the Board's last four annual reports, is renewed:

Vessels navigating the St. Croix River need a light to guide them to its entrance between the whirlpools off Deer Point and Dog Island, near Eastport. Clark Ledge, near the shore in Eastport Harbor, almost covered at high water, is very dangerous to navigation, and has caused the loss of several vessels. A light here would

First District.

serve the twofold purpose of guiding vessels to the entrance of the river and clear of this dangerous ledge. For this purpose an appropriation of \$30,000 is needed. The legislature of Maine, which convenes biennially and will not again assemble until the winter of 1890-'91, has conveyed title to the ledge and jurisdiction over it to the United States, so that the light-house may be erected whenever an appropriation therefor is made by Congress.

It is recommended that an appropriation of \$30,000 be made therefor.

5. *Little River, mouth of Little River, Cutler Harbor, Maine.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

Cutler Harbor is a station of the Eastport, St. John, and Bay of Fundy pilots. It is rapidly growing as a summer resort. Vessels making the Bay of Fundy first make Libby Islands, and then try to make Little River light. Steamers of the International Line wish to make this a harbor and stopping place. They carry much freight and many passengers. It is the only near harbor of refuge, and is used as such by vessels when they can get in; but this is impossible in a fog, without the aid of a fog signal. The Spanish steamer, *Eduardo* struck at low tide on July 21, 1889, on Old Man Island, 2 miles south of Cutler Harbor, at midnight and during a dense fog. She filled with water and proved a total loss. The crew, numbering 40 men in all, were saved. She registered 2,308 tons and cost \$285,000. The inspector of the first light-house district made a report relating to this wreck, from which the following extracts are taken:

"The steamer *Eduardo* arrived near Libby Islands light and fog-signal station on the morning of July 20, and remained in that vicinity until near midnight, occasionally standing out seaward and then returning, apparently keeping between the two signals of Libby Islands and Seal Island.

"The weather was calm, with a rough sea and dense fog. About 9 p. m. it scaled up so that Libby Islands and Moose Peak lights were visible, and soon after the vessel was headed east by north at slow speed, with frequent casts of the lead.

"At about midnight, fog being very thick, the vessel struck on Old Man, having heard neither the automatic fog bell of Little River light-station, 2¾ miles distant to the eastward, nor the whistling buoy off same place, 3½ miles distant, bearing about E. ½ N."

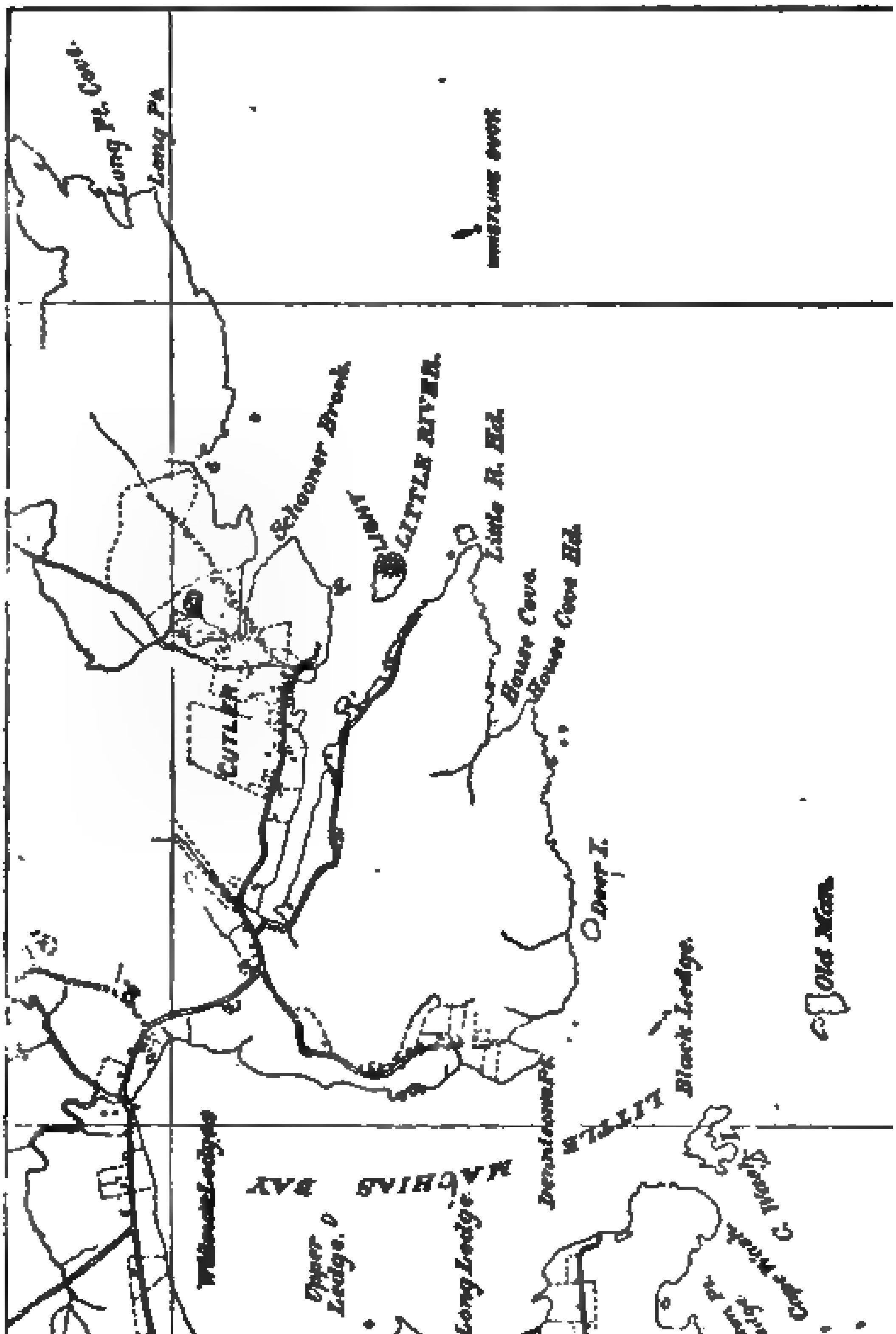
From an inspection of the chart it will be seen that Little River and Harbor opens to the southeast and that the high land of Little River Head covers the light-station until it is brought to bear about north. A steam fog signal at the light-station might or might not be heard near the Old Man; it would not be heard certainly at its full strength; but located on Little River Head it would be exposed in all directions seaward and would in this case, without any doubt, have been the greatest possible assistance in guiding the *Eduardo* to that point; the whistling buoy could then have been picked up and a fresh departure taken, or the vessel could have entered the harbor of Cutler.

The following is an extract from the report of her master of the wreck of the *Eduardo:*

"If at the western point of Little River there had been a fog whistle or trumpet, I assure you this accident would not have occurred; so that, in my opinion, it is absolutely necessary there should be at that point some fog signal operated by steam during foggy weather."

The Board is also of opinion that this wreck would not have occurred had the fog signal now recommended for Little River light-station then been in operation. It is estimated that the establishment of such a signal would cost \$10,500, and the appropriation of that amount is therefore recommended.

First District.



7. Libby Islands, entrance to Machias Bay, Maine.—A reservoir 17 feet 2 inches by 19 feet in plan by 6 feet 7 inches deep, was built under the rain shed, which, with the other reservoirs at the station, makes a storage capacity of 50,000 gallons of rain water for fog signal use. The characteristic of the fog signal was changed from a blast of four seconds' duration and an interval of twenty-six seconds, to a blast of four

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seconds, interval four seconds, blast four seconds, interval eighteen seconds, to enable mariners to distinguish more readily between it and the fog signal on Machias Seal Island, which has a characteristic of five seconds' blast and twenty-five seconds' interval. A brick oil house 9 feet 4 inches by 11 feet in plan was built. Since the recommendation of last year for an appropriation for a single dwelling for an assistant keeper, it has become necessary to provide quarters for another assistant, making two sets of quarters urgently needed, as there is now but one set for three keepers. It is therefore recommended that a double dwelling be built, at an estimated cost of $6,200, instead of the single dwelling heretofore recommended.

8. *Moose Peak, Mistake Island, entrance to Bay of Fundy, Maine.*—A brick cistern for domestic water supply was built in the cellar of the assistant keeper's house.

14. *Winter Harbor, Mark Island, Maine.*—The boathouse was remodeled and enlarged and minor repairs were made to the dwelling.

15. *Mount Desert, Mount Desert Rock, Atlantic Ocean, off the coast of Maine.*—At this isolated station very little work in the way of repairs was done for a number of years, and the station, at the commencement of operations in August, 1892, was in great need of a thorough overhauling. The old stone dwelling which was built in 1846, and deteriorated beyond repairs, was replaced by a substantial frame double dwelling, making a comfortable set of quarters for two keepers. The exterior walls, floors, ceilings, etc., of the tower were extensively repaired, and the tower put in first-class condition. A covered way, about 30 feet long, was built from near the dwellings to the light tower, a storm porch was built at the entrance of the keeper's dwelling, the underpinning was partially relaid, and repairs were made to the plastering and floors. Walks 250 feet in length were laid from the dwellings to the outbuildings and the boat slip was extended 20 feet seaward. A cellar was dug, a cistern of about 800 gallons' capacity, and several outhouses were built.

19. *Great Duck Island, southern extremity of Great Duck Island, Maine.*—The boundary fence on both sides of the reservation was extended to the sea and the boat slip was extended 30 feet.

—. *Green Island, entrance to Burnt Coat Harbor, Maine.*—The following recommendation, made in the Board's estimates and reports for the last eight years, is repeated:

> Burnt Coat Harbor is an excellent, capacious harbor of refuge. The range lights which guided to the entrance were unsatisfactory, and a vessel was wrecked last year while trying to make the harbor by their aid. One of them was accordingly discontinued, and it is proposed to erect in its stead a light-house on Green Island, about a mile to the southward of the entrance. It is recommended that an appropriation of $12,000 be made therefor.

29. *Heron Neck, on Green Island, East Penobscot Bay, Maine.*—The fol-

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lowing recommendation, made in the Board's last two annual reports, is renewed:

The keeper's dwelling, built when the station was established in 1853, was designed to be an excellent one, having 8-inch brick walls separated by a 2-inch air space from a 4-inch brick lining, and having interior 4-inch brick partitions. It is, however, understood to have been built by contract, and so little mortar was used that many of the joints do not appear to have been filled. In driving rain storms they receive large quantities of water, which keep the walls very damp and almost incessantly exude moisture into the dwelling. The dampness of the dwelling is further increased by the character of the site, which is underlaid by a sloping ledge, over which the water flows, saturating the soil surrounding the dwelling and keeping its cellar wet. From these causes the dwelling is unhealthy, and it is unsuitable for occupancy in so severe a climate. It is claimed that on this account five deaths have occurred in it since its erection in 1853. It would cost to remedy these radical defects in the walls and of the site almost, if not quite, as much as it would to erect a new building on a proper site. A new building on a better site, it is estimated, would cost $3,300, and it is recommended that an appropriation of this amount be made for that purpose.

30, 31. Matinicus Rock, on Matinicus Rock, Atlantic Ocean, off the coast of Maine.—The workroom at the south tower and the tramway from the boathouse to the signal house were rebuilt. Various repairs were made. The following recommendation, which was made in the Board's last two annual reports, is renewed:

For more than twenty years, and until recently, the first assistant keeper was the son of the principal keeper, and the two lived together in one dwelling. The resignation of the principal keeper has broken up this arrangement. At this important station, which has two second-order lights and a steam fog signal, a keeper and three assistant keepers are employed. These are the only people living on this rock. Two of the assistant keepers, with their families, live in one double dwelling, and the principal keeper lives in a separate single dwelling. These three sets of quarters are adapted only to the accommodation of three families, and a fourth set of quarters is therefore urgently necessary for the third assistant. It is estimated that a proper dwelling can be built for $3,200, and recommendation is made that this amount be appropriated for that purpose.

This bare, rocky islet is about half a mile long and of irregular width, nowhere exceeding an eighth of a mile, and the highest part is not more than 50 feet above the sea level. There is a little cove where material can be hauled up in pleasant weather, but it has no harbor. The light-house keeper effects a landing by steering his boat through the breakers on the top of a wave, so that it will land on the boatways, where his assistants stand ready to receive him and draw his boat so far up on the ways that a receding wave can not carry it back to the sea. There is neither tree nor shrub and hardly a blade of grass on the rock. The surface is rough and irregular, and resembles in a large way a confused pile of loose stone. Portions of the rock are frequently swept by the waves, which move the huge bowlders into new positions. During the storm of January 19, 1856, the sea made a complete breach over the rock, washing away every movable thing. The old dwelling was so thoroughly demolished that not one stone was left upon another. The then new dwelling, though situated in the most protected spot, was flooded, and heavy wooden shutters had to be closed to prevent the violence of the spray from breaking them in. The rock is about 20 miles from the mainland, as the crow flies. Rockland, 25 miles distant, is the nearest harbor, unless the coves of Matinicus Island, 4 miles

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from the rock, be considered as harbors. They can be entered only with certain winds by vessels of very light draft. The isolation of this station and the difficulty of landing material here of course enhance the cost of erecting the proposed structure, in which strength rather than the graces of architecture are most considered.

—. *Two-Bush Island, southeast point, entrance to West Penobscot Bay, seacoast of Maine.*—The establishment of a light-station here, at a cost not exceeding $19,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

34. *Rockland Breakwater, north side of the entrance to Rockland Harbor, Maine.*—The light was moved to the end of the breakwater extension, a new beacon post was erected in place of the old one, and two fixed red lanterns, one above the other, 6 feet apart, were substituted for the fixed white lantern.

40. *Fort Point, mouth of the Penobscot River, Maine.*—The fuel house was rebuilt and the barn was repaired.

49. *Cuckolds Island fog-signal station, off Southport Island, coast of Maine.*—An appropriation of $25,000 was made by the act approved March 3, 1891, for establishing this fog signal. The site of the structure is at the top of a barren rock about 16 feet above high water, and is washed by the sea in heavy storms. The structure consists of a semicircular granite pier 36 feet in diameter and 12 feet high, hollow in the center for fresh-water cisterns and storeroom. It is surmounted by a brick fog-signal house of a similar form, but of smaller diameter. A substantial double dwelling having a heavy, hard pine frame, well bolted to the ledge, is in the rear of the pier. A bulkhead of hard pine, 60 feet long, protects the dwelling and outbuildings. The boat-house and boat slip are on the west side of the rock, protected from the sea.

There were used in the construction of the station 105 yards of granite masonry, 430 casks cement, 60,000 bricks, 100 tons sand, 200 tons of broken stone and pebbles, 70,000 feet of lumber, inclusive of the false work, 3,400 pounds wrought-iron work, 5,900 pounds columns and railings, 4,000 pounds of beams, about 650 tons in all.

The material was bought under contract, and the greater part was carried to the station by the tender *Myrtle* in connection with other work in the vicinity. The work was done by hired labor, with the plant belonging to the Light-House Establishment and kept in this district. Work was commenced at the site April 22, 1892, and was finished November 16, 1892. The cost of the structures and machinery complete in place was $24,750.

—. *Perkins Island, Squirrel Point, Doubling Point, Ames Ledge light-stations, Kennebec River, Maine.*—The following recommendation made in the Board's last annual report is renewed:

There were 3,137 arrivals of vessels in this river during the year, not counting the steamers which ply daily. The steamers *Kennebec*, 1,652 tons, and *Sagadahoc*, 1,413

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tons, made ninety-six round trips each from Gardiner to Boston. Other passenger steamers ply on the river from Bath to Augusta, Boothbay, and Popham Beach, and intermediate places. The number of passengers carried was 232,150. Seventeen tugs were engaged on the river in towing. Thirty-nine vessels of 32,063 gross tons were built on the river, valued at $50 per gross ton, or, say, $1,603,150. The vessels arriving will average 450 tons. Some 24 feet draft can be carried to Thwings Point, 6 miles above Bath, 16 feet draft from Thwings Point to Gardiner, and 8 feet from Gardiner to Augusta. The Kennebec River is kept open by the towboats during the winter from Bath to the sea. Above Bath the buoys are taken up about November 20, and the river is likely to freeze at any time after this date. The ice usually goes out early in April. The river not only has the sea fogs, which extend to Bath, but its own river fog or mist, which is dense and at times low down. On dark nights it is sometimes impossible to tell where the water ends and the shore begins. The Light-House Establishment maintains no lights or fog signals in the Kennebec, but the Kennebec Steamboat Company and the towboat companies have united for many years in maintaining lanterns hung on the buoys at turning points or other difficult places. The above facts establish, in the Board's opinion, the necessity for and advisability of increasing the aids to navigation in the Kennebec River, and it recommends the establishment of the following-named lights:

On the southwest point of Perkins Island a fixed red lens lantern light, with a white sector to the northward and a fog bell struck by machinery, at an estimated cost of $5,700.

At Squirrel Point a fixed red light from a lens lantern, with a white sector to the southward, at an estimated cost of $4,650.

At Doubling Point a red lens-lantern light, showing up and down the river, with a fog bell, and one-half mile east from the point white range lights, not less than 500 feet apart, to mark the channel from Ram Island to Fiddlers Reach, at an estimated cost of $6,300.

At Ames Ledge, just above Thwings Point, a red lens lantern, mounted on the wooden spindle, which is maintained there during the navigable season, at an estimated cost of $75.

It is estimated that these four light-stations can be established for not exceeding $16,725, and it is recommended that an appropriation of this amount be made therefor.

54, 55. *Cape Elizabeth, Maine.*—The following recommendation, made in the Board's last two annual reports, is renewed:

Until the resignation of the principal keeper, about two years ago, his wife was an assistant keeper, so that there were but three families to be accommodated in the three single dwellings at the station. This arrangement is changed, and there are now four separate families at the station, and two families are crowded into a dwelling adapted in size and arrangement to only one family. The two towers are more than 900 feet apart; two of the dwellings are near the northeast and one near the southwest tower. A fourth dwelling is very urgently needed near the latter to properly and conveniently house in the severe winter weather of that climate the second of the two assistants who attends the light in it. Besides a first and a second order light, the station has a first-class fog signal, and an additional dwelling is imperatively needed in the best interests of the service. It is estimated that one can be built for $3,300, and it is recommended that an appropriation of this amount be made therefor.

—. *Spring Point Ledge, Portland Harbor, Maine.*—The following recommendation, made in the Board's last two annual reports, is renewed:

A bell should be placed on Spring Point Ledge, Portland Harbor, at a point where it would mark that dangerous ledge, which lies in bold water at the edge of the

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channel. It would also mark a turning point, and would be of great service to vessels making their way into Portland Harbor in thick weather, going either to the wharves, to an anchorage in Diamond Island Roads, or to the westward of Fort Gorges. At present they have to grope their way unaided after leaving the bell buoy off Cushing Island Point. When the sea is exceptionally calm this buoy does not ring, and there is no guide for vessels from the time they pass the trumpet at Portland Head. With a bell on Spring Point Ledge, vessels could always change their course there in thick weather, without depending, as they now do, on their time from the bell buoy or from Portland Head, 2 miles distant. The difficulty is increased by the liability of the reckoning being lost in meeting other vessels which throng the harbor, and some of which even anchor in the channel in the midsummer season, when the fogs are most dense and frequent.

The peril to vessels in thick weather is also somewhat increased by the tendency of a current, issuing at some states of the tide between Cushing (Bangs) Island and Fort Scammel, to set vessels toward the Spring Point side of the channel, and of the ebb current to set them in a southerly direction on to Spring Point Ledge.

Seven steamship companies own steamers which enter Portland Harbor. They embrace the regular coastwise lines, one foreign line, and the steamers plying between Portland and places in the immediate vicinity which are of daily resort in summer. These companies claim that 518,362 passengers were carried into Portland by their steamers last year, as follows:

Casco Bay Company	317,285
Portland Steam Packet Company	75,482
International Steamship Company	40,325
Maine Steamship Company	4,495
Harpswell Steamboat Company	6,000
Portland and Boothbay Steamboat Company	3,000
Steamer *Greenwood*	36,000
Steamer *S. E. Spring*	35,000
Allan Steamship Line	775
Total	518,362

In view of the excellence and importance of the harbor, the very large number of vessels which annually resort to it for refuge, the great number of passengers carried into it, which will doubtless steadily increase with the increasing number of people who resort to the coast of Maine in midsummer, and the frequency and density of the fogs at the very period when the passenger traffic is greatest, it is recommended that provision be made for the establishment upon Spring Point Ledge of a fog bell and a light of the fifth order, in a depth of water not to exceed 12 feet at mean low tide, and the building of a structure of about the type and diameter of those at Crabtree Ledge and Goose Rocks, Maine. It is estimated that this can be done for $45,000, and it is recommended that an appropriation of this amount be made for that purpose.

61. *Boon Island, seacoast of Maine.*—The following recommendation, made in the Board's last two annual reports, is renewed:

There are at this station one keeper and two assistants, and but two sets of quarters in one double dwelling. The second assistant keeper has to board either with the family of the keeper or with that of the first assistant keeper. This forced arrangement is unsatisfactory to all, and is quite unfavorable to the retention of a second assistant of the needed qualifications. The station is isolated and exposed, the tower is tall, and this second-order light is an important one. A third dwelling, which is urgently needed, it is estimated can be built for $3,400. It is therefore recommended that an appropriation of this amount be made therefor.

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REPAIRS.

Repairs, more or less extensive, were made during the year at the following-named stations:

2. St. Croix River, Me.
3. Lubec Channel, Me.
4. West Quoddy Head, Me.
5. Little River, Me.
6. Avery Rock, Me.
7. Libby Islands, Me.
8. Moose Peak, Me.
9. Moosabec Reach, Me.
10. Nash Island, Me.
12. Petit Manan, Me.
13. Prospect Harbor, Me.
16. Egg Rock, Me.
17. Crabtree Ledge, Me.
18. Baker Island, Me.
19. Great Duck Island, Me.
20. Bear Island, Me.
21. Bass Harbor Head, Me.
23. Blue Hill Bay, Me.
24. Saddleback Ledge, Me.
25. Deer Island Thoroughfare, Me.
27. Eagle Island, Me.
30, 31. Matinicus Rock, Me.
32. Whitehead, Me.
33. Owls Head, Me.
34. Rockland Breakwater, Me.
35. Browns Head, Me.
36. Indian Island, Me.
37. Negro Island, Me.
38. Grindel Point, Me.
39. Dice Head, Me.
41. Tennant Harbor, Me.
43. Monhegan Island, Me.
44. Manana Island, Me.
45. Franklin Island, Me.
47. Ram Island, Me.
48. Burnt Island, Me.
51. Pond Island, Me.
52. Seguin, Me.
53. Halfway Rock, Me.
54, 55. Cape Elizabeth, Me.
56. Portland Head, Me.
57. Portland Breakwater, Me.
60. Cape Neddick, Me.
61. Boon Island, Me.
62. Whaleback, N. H.
64. Isles of Shoals, N. H.

SURVEYS.

The light-house lands were surveyed, their boundaries were marked with stone posts or copper bolts, contours were located by plane table, and the buildings were measured for ground plans at

21. Bass Harbor Head, Me.

Topographical surveys, with location of contours and measurement of buildings, were made at the following stations:

2. St. Croix River.
4. West Quoddy Head.
5. Little River.
6. Avery Rock.
10. Nash Island.
12. Petit Manan.
13. Prospect Harbor.
39. Dice Head.
64. Isles of Shoals.

Plans of the light-house land showing in detail the contours and buildings, were made at

2. St. Croix River.
4. West Quoddy Head.
5. Little River.
6. Avery Rock.
10. Nash Island.
12. Petit Manan.
13. Prospect Harbor.
21. Bass Harbor Head.
39. Dice Head.
42. Marshall Point.
64. Isles of Shoals.

First District.

DAY OR UNLIGHTED BEACONS.

Ash Island Beacon, east point of Ash Island, Penobscot Bay, Me.—The tripod was rebuilt.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

4. West Quoddy Head, Maine.—This 10-inch steam whistle, in duplicate, was in operation 1,465 hours during the year, and consumed about 71 tons of coal. One signal is in good condition, the other is under repairs.

7. Libby Islands, Maine.—This 10-inch steam whistle, in duplicate, was in operation 1,554 hours during the year, and consumed about 85 tons of coal. A larger water supply is necessary. The keeper has been forced to use salt water in the boiler for some time.

12. Petit Manan, Maine.—The 10-inch steam whistle, in duplicate, was in operation 1,927 hours during the year, and consumed about 69 tons of coal. Both signals are in good condition.

15. Mount Desert, Maine.—This third-class Daboll trumpet, in duplicate, was in operation 1,433 hours during the year, and consumed about 7 tons of coal. It is in good condition.

19. Great Duck Island, Maine.—The 10-inch steam whistle, in duplicate, was in operation 1,315 hours during the year, and consumed about 56 tons of coal. Both signals are in good condition.

30, 31. Matinicus Rock, Maine.—The signals of this station, a 10-inch and a 12-inch steam whistle, were in operation 1,406 hours during the year, and consumed about 60 tons of coal. Both signals are in good condition.

32. Whitehead, Maine.—This 10-inch steam whistle, in duplicate, was in operation 991 hours during the year, and consumed about 61 tons of coal. Both signals are in good condition.

44. Manana Island, Maine.—This first-class Daboll trumpet, in duplicate, was in operation 1,038 hours during the year, and consumed about 13 tons of coal. Both signals are in good condition.

49. Cuckolds Island, Maine.—This Daboll trumpet, in duplicate, was in operation 532 hours during the year, and consumed about 3½ tons of coal. It was put in operation for the first time December 15, 1892. Both signals are in good condition.

52. Seguin, Maine.—This 10-inch steam whistle, in duplicate, was in operation 1,119 hours during the year, and consumed about 50 tons of coal. Both signals are in good condition.

54, 55. Cape Elizabeth, Maine.—The signals are a second-class steam siren and a 12-inch steam whistle. They were in operation 705 hours during the year, and consumed about 43 tons of coal. One signal is in good condition, the other is under repairs.

First District.

56. Portland Head, Maine.—This second-class Daboll trumpet, in duplicate, was in operation 799 hours during the year, and consumed about 10 tons of coal. Both signals are in good condition.

62. Whaleback, New Hampshire.—This third-class Daboll trumpet, in duplicate, was in operation 1,061 hours during the year, and consumed about 6 tons of coal. Both signals are in good condition.

BUOYAGE.

Thirteen new spar buoys were established. The wooden tripod on the Cuckolds, Boothbay Harbor, was discontinued. The spar buoy on Horse Ledge, Moosabec Reach, and Middle Ground buoy, Machias River, were changed from spars to second-class cans, and Witch Rock buoy, off Portland Head, was changed from a second to a first class nun.

DEPOTS.

Little Diamond Island, Portland Harbor, Maine.—This depot is in excellent condition.

Bear Island, Mount Desert, Maine.—The work of extending the wharf on the north side, 50 by 100 feet, commenced June 13, 1893, was completed, and it is in excellent condition.

Whitehead, Maine.—The wharf and coal shed at this depot are in excellent condition.

TENDERS.

The Iris.—The tender *Iris* was sold at auction on December 15, 1892, after due public advertisement, for $2,200, which amount was covered into the Treasury.

The *Iris* steamed 2,540 miles and consumed about 80 tons of coal.

The Lilac.—The steam tender *Lilac* was received from the contractors and placed in commission on August 3, 1892. In January, 1893, the superstructure deck was extended, inclosing the after part of the main deck. She was placed on the marine railway in December, 1892, and May, 1893, when her bottom was cleaned and painted and minor repairs were made to the engines and hull.

The *Lilac* was laid up for repairs thirty-two days. She steamed 14,469 miles and consumed 841 tons of coal.

The two tenders replaced 142 buoys, changed 112 buoys, painted 476 buoys, made and ironed 270 buoys, landed at light-stations 515 tons of coal, and their crews did forty-nine days' work at the buoy depot.

SECOND DISTRICT.

The second district extends from Hampton Harbor, New Hampshire, to, but does not include, Elisha Ledge, off Warren Point, Rhode Island, and embraces all the aids to navigation on the coast of Massachusetts except a small portion of Narragansett Bay and Taunton River.

Inspector.—Commander George F. F. Wilde, U. S. Navy.

Engineer.—Maj. William R. Livermore, Corps of Engineers, U. S. Army.

In this district there are—

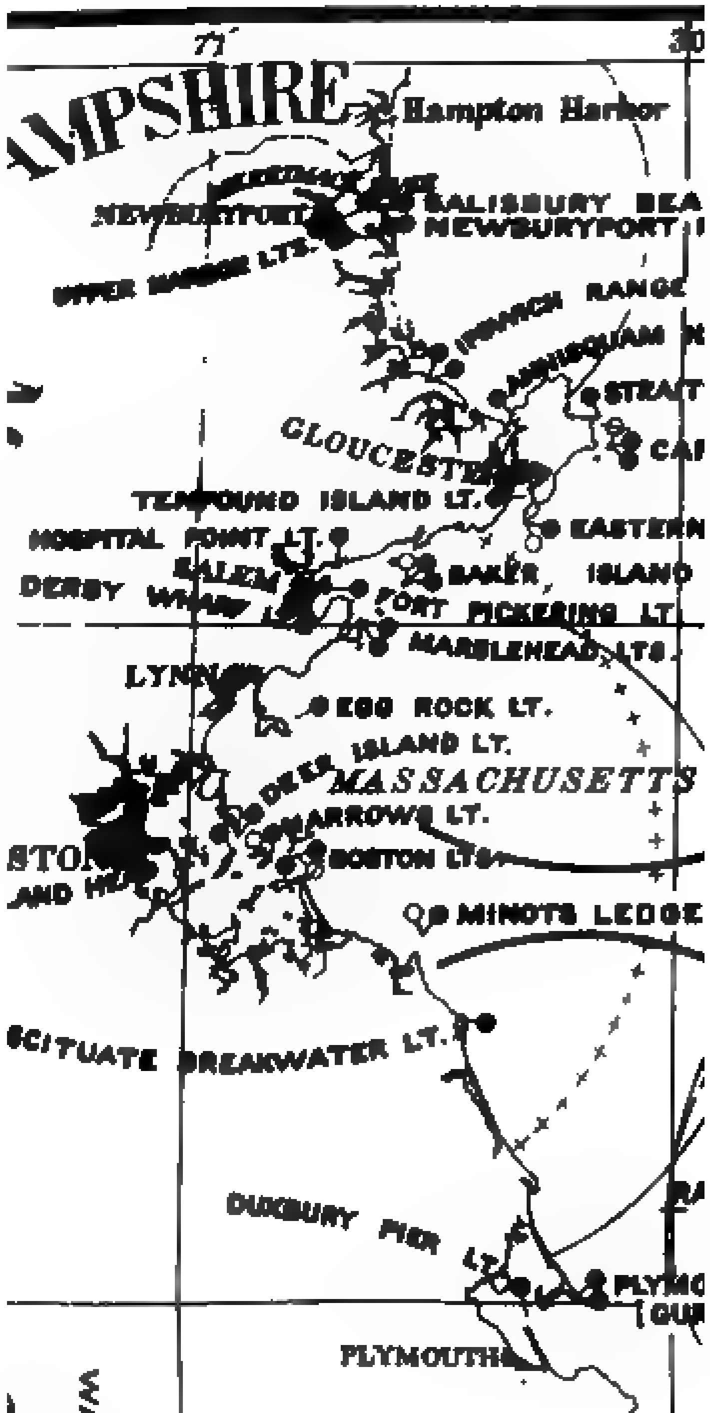
Light-houses and lighted beacons	70
Light-ships in position	9
Light-ships for relief	2
Day or unlighted beacons	72
Fog signals operated by steam or hot-air engines	9
Fog signals operated by clockwork	10
Lighted buoys in position (gas)	2
Whistling buoys in position	11
Bell buoys in position	16
Other buoys in position	489
Ice buoys for winter use	17
Steamers *Verbena*, *Geranium*, and *Azalea*, buoy tenders and for supply and inspection	3
Steamer *Myrtle*, for construction and repair in the first and second districts	1

LIGHT-HOUSES.

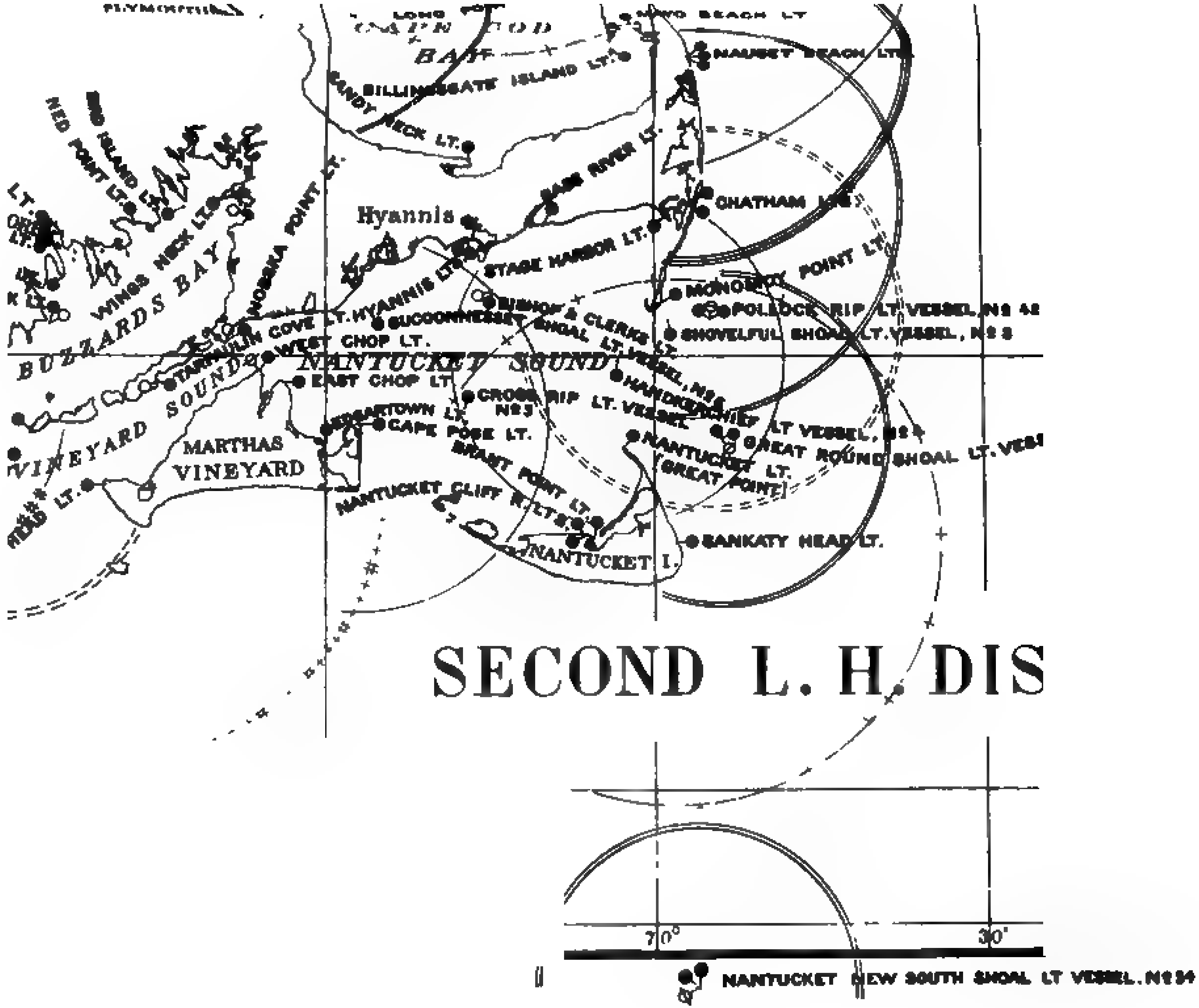
6[illegible]. *Newburyport Harbor, Plum Island, Merrimack River, Massachusetts.* Materials for an oil house were landed at the station. Repairs were made.

[illegible]. *Baker Island, north part of Baker Island, Massachusetts.*—Materials for an oil house were landed at the station. Repairs were made.

[illegible]. *Marblehead, entrance to Marblehead Harbor, Massachusetts.*—Marblehead has a deep capacious harbor, which is nearly landlocked. For nearly sixty years a light has been maintained to guide vessels in and out of this harbor, especially the fishermen, who from the very nature of their business find it necessary to enter and leave the harbor at any and all times at night as well as by day. Many merchant vessels loaded with coal and general merchandise ply between this and other ports along the shore, and scores of yachts with hundreds of



MPSHIRE
Hampton Harbor
SALISBURY BEA
NEWBURYPORT
UPPER HARBOR LTS.
IPSWICH RANGE
ANNISQUAM
STRAIT
GLOUCESTER
TEN POUND ISLAND LT.
EASTERN
HOSPITAL POINT LT.
SALEM
BAKER ISLAND
DERBY WHARF LT.
FORT PICKERING LT.
MARBLEHEAD LTS.
LYNN
EGG ROCK LT.
DEER ISLAND LT.
MASSACHUSETTS
NARROWS LT.
BOSTON LTS.
MINOTS LEDGE
SCITUATE BREAKWATER LT.
DUXBURY PIER LT.
PLYMOUTH


SECOND L. H. DIS
CAPE COD BAY
BILLINGSGATE ISLAND LT.
SANDY NECK LT.
NAUSET BEACH LT.
BASS RIVER LT.
CHATHAM LTS.
Hyannis
STAGE HARBOR LT.
MONOMOY POINT LT.
POLLOCK RIP LT. VESSEL, Nº 42
SHOVELFUL SHOAL LT. VESSEL, Nº 8
BISHOP & CLERKS LT.
LT. HYANNIS LT.
SUCCONNESSET SHOAL LT. VESSEL, Nº 6
NED POINT LT.
BIRD ISLAND LT.
WINGS NECK LT.
NOBSKA POINT LT.
BUZZARDS BAY
TARPAULIN COVE LT.
WEST CHOP LT.
NANTUCKET SOUND
EAST CHOP LT.
CROSS RIP LT. VESSEL Nº 3
HANDKERCHIEF LT. VESSEL, Nº 2
GREAT ROUND SHOAL LT. VESSEL
VINEYARD SOUND
EDGARTOWN LT.
CAPE POGE LT.
MARTHAS VINEYARD
NANTUCKET LT. (GREAT POINT)
BRANT POINT LT.
NANTUCKET CLIFF R. LTS.
SANKATY HEAD LT.
NANTUCKET I.
70°
30'
NANTUCKET NEW SOUTH SHOAL LT VESSEL. Nº 54

Second District.

pleasure seekers, make this their headquarters during the summer. The harbor, when not properly lighted, is difficult of approach, especially from the south and west. Mariners, ship owners, and others have complained for some years that the many dwellings lately built obscure the light. The difficulty has been partly overcome by showing a light from a lantern hoisted on a mast; but this is only a makeshift. The safety of commerce absolutely requires that a higher tower be erected. It is now proposed, therefore, to build a brick tower about 100 feet high, on the site of the present tower, at an estimated cost of $45,000, and it is recommended that an appropriation of this amount be made therefor.

—. *Spectacle Island, Boston Harbor, Massachusetts.*—The following recommendation, made in the last annual report, is renewed:

Boston is one of the most important commercial cities in the country. Its harbor is without sufficient aids to navigation. Among those most needed are range beacons on Spectacle Island to mark the center of the dredged channel from State Ledge toward the city and to mark the turning point into the channel for vessels coming up from Nix Mate. The front beacon should be on a pyramidal wooden tower 13 feet high, the base being 8 feet above mean high water. The rear range should be on a similar tower 16 feet high, its base being about 35 feet above mean high water. The station would need a dwelling for the light-keeper, a fuel house, a boathouse, and a boat slip, with an acre of land for a light-house site and a right of way from it to the nearest road. It is estimated that the range lights can be established for not exceeding $9,350, and it is recommended that an appropriation of this amount be made therefor.

—. *South Boston range lights, Massachusetts.*—The following recommendation, made in the last annual report, is renewed:

Ranges should be established on the Marine Park Pier and at City Point, South Boston, to guide vessels coming up Boston Harbor from Nix Mate to State Ledge turn. The range at South Boston City Park should be a mast 50 feet high, with crosstrees 10 feet long, supporting a red lantern at each end. The range beacon at the Marine Park Pier should be a mast reaching about 30 feet above the driveway, supporting two red lanterns, one 6 feet above the other. It is estimated that the range lights can be established for not exceeding $1,000, and it is estimated that an appropriation of this amount be made therefor.

—. *State Ledge, Boston Harbor, Massachusetts.*—The following recommendation, which was made in the Board's last five annual reports, is renewed:

The ship channel, from the Boston wharves to Nix Mate Buoy, has no aids to navigation except buoys. Vessels find it very difficult in thick weather and at night to keep in the channel, and they are particularly perplexed to know just where to turn in the neighborhood of State Ledge and buoy No. 8, both in leaving and entering the harbor. Large excursion steamers, as well as steamers of the regular lines running out of Boston, frequently have to anchor in thick weather solely because they have no guide between Nix Mate Buoy and the wharves. This greatly incommodes business men going and coming during the summer months when fogs are prevalent. The Board has recognized for a long time the necessity for a light and fog signal at

Second District.

this point, but has postponed action while the improvements in the channel of the harbor in charge of the United States engineers were in progress. Although these improvements have not yet been entirely finished they are practically concluded in that vicinity, and the Board is of opinion that the time has arrived when a light and fog signal ought to be established near buoy No. 8, or at or near State Ledge. It is estimated that it will cost $42,000 to establish a light and fog signal at this point.

It is recommended that an appropriation of this amount be made therefor.

93, 94. Plymouth (Gurnet), on Gurnet Point, entrance to Plymouth Harbor, Massachusetts.—Materials for an oil house were landed at the station. Some repairs were made.

106, 107. Chatham, west side of Chatham Harbor, Massachusetts.—A brick oil house, 9 feet 4 inches by 11 feet, was built. Some repairs were made.

109. Monomoy Point, southern extremity of Cape Cod, Massachusetts.—Materials for an oil house were landed at the station. Repairs were made.

127. Cape Poge, east part of Marthas Vineyard, Massachusetts.—A new temporary light tower, made necessary by the washing away of the bank, was built 40 feet distant from the old one. The old tower, which was very much out of repair, was taken down and the light was removed to the new tower. Repairs were made.

—. *Butler Flat, New Bedford Harbor, Buzzards Bay, Massachusetts.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

The entrance near buoy No. 9, on the point of Butler Flat, is narrow, obscure, and difficult to find in snowstorms, fogs, and dark nights. If a light with a fog signal was placed on that point it would mark both the entrance and turning point; would guide vessels to an anchorage in the lower harbor, and, with the light on Palmer Island, would guide them clear of North Ledge, Henrietta and Hurricane Rocks, in Buzzards Bay, and be of great service to the navigation of this important port. It is stated by the custom-house authorities that 1,814 vessels entered the port of New Bedford during 1887, not including yachts, fishing craft, or boats. It is also stated that the Vineyard Sound and Nantucket steamers took 75,000 passengers to and from this port and received $22,500 for freight carried. It is further stated that the New York propellers made 104 trips between New York and New Bedford, and received over $100,000 for freight carried. New Bedford is now said to be the third manufacturing city in Massachusetts, and the collector of the port states that about [illegible] tons of shipping came into the port during last year.

The Board, as stated in its last annual report, is of the opinion that the needs of commerce and navigation require the establishment of a light and fog signal at this point. It is estimated that they can be erected for $45,000, and it is recommended that an appropriation of this amount be made therefor.

Second District.

REPAIRS.

At each of the following-named stations, repairs of greater or less extent were made during the year:

65, 66. Salisbury Beach, Mass.
70, 71. Ipswich, Mass.
72. Annisquam, Mass.
73. Straitsmouth, Mass.
74, 75. Cape Ann, Mass.
76. Eastern Point, Mass.
80. Hospital Point, Mass.
82. Derby Wharf, Mass.
86. Minots Ledge, Mass.
87, 88. Boston, Mass.
89. Narrows, Mass.
90. Deer Island, Mass.
91. Long Island Head, Mass.
92. Scituate Breakwater, Mass.
96. Race Point, Mass.
98. Long Point, Mass.
99. Mayo Beach, Mass.
102. Cape Cod, Mass.
103, 104, 105. Nauset Beach, Mass.
113. Nantucket, Mass.
114. Sankaty Head, Mass.
116. Gay Head, Mass.
120. Stage Harbor, Mass.
121. Bass River, Mass.
122. Bishop and Clerks, Mass.
123, 124. Hyannis, Mass.
130. West Chop, Mass.
131. Nobska Point, Mass.
132. Tarpaulin Cove, Mass.
135. Cuttyhunk, Mass.
136. Dumpling Rock, Mass.
138. Palmer Island, Mass.
141. Ned Point, Mass.
142. Bird Island, Mass.
143. Wings Neck, Mass.

SURVEYS.

The light-house lands were surveyed, their boundaries were marked with stone posts or copper bolts, contours were located by plane table, and the buildings were measured for ground plans at

72. Annisquam Harbor.
92. Scituate Breakwater.

Measurements for new buildings were made at

76. Eastern Point.

Plans of the light-house land, showing in detail the contours and buildings, were made at

72. Annisquam Harbor.
92. Scituate Breakwater.
114. Sankaty Head.
135. Cuttyhunk.

LIGHT-SHIPS.

—. *Boston light-vessel, entrance to Boston Harbor, Massachusetts.*—The following recommendation, which was made in the Board's last annual report, is renewed:

A vessel moored about 6 nautical miles E. by S. of Boston Light, showing two red lights, would be of great value to incoming vessels. The well-known difficulty in determining the location of the Boston Light, when approaching in thick weather, and the doubtful utility of the bell at Minots Ledge are strong reasons why this aid to navigation should be established. It is estimated that a first-class light-ship with steam fog signal and auxiliary steam moving power would cost $70,000 and it is recommended that an appropriation of that amount be made therefor.

108. Pollock Rip light-vessel, No. 47, off Chatham, Cape Cod, Massachusetts.—On November 1, 1892, light-ship No. 42, which had been for

Second District.

a long time on this station, was transferred with her keepers and crew to Great Round Shoal station. She was replaced by the new light-ship, No. 47, built at South Boston. This vessel is well adapted to the necessities and requirements of this station. On October 1, 1892, the schooner *Lucy*, in attempting to cross her bows, fouled, and did some slight damage to the fender, scupper, etc., of the light-vessel. On the 22d, an unknown schooner also fouled the light-ship, starting and bending her stem.

110. Shovelful Shoal light-vessel, No. 3, off Monomoy Point, Cape Cod, Massachusetts.—She was brought to New Bedford, April 20, and her copper was renewed at the water-line, a riding stopper was put in, some calking was done, and various repairs were made. On May 10, she resumed her station. On February 25 the schooner *Woodside* collided with the light-ship. No damage was done to the vessel herself, but her boat was stove. A new boat was built for her, and it was paid for by the owners of the schooner. A lightning rod, rubber hose, and galley stove were supplied.

111. Handkerchief light-vessel, No. 4, Nantucket Sound, Massachusetts.—On May 1 this vessel was brought to New Bedford and her copper was renewed in part. A riding stopper was put in, and repairs were made to her stem. On June 3 she resumed her station. On October 27, 1892, she was fouled by a schooner. No harm was done to the vessel herself, but her spare boat was somewhat damaged.

112. Great Round Shoal light-vessel, No. 42, off Nantucket, Massachusetts.—On November 1, 1892, light-ship No. 47 was transferred, with her officers and crew, from this station to Pollock Rip station, and light-ship No. 42 was so placed as to mark Great Round Shoal. The boilers of this vessel are in a bad condition and liable to give out at any time. No repairs were made to the ship during the year.

115. Nantucket New South Shoal light-vessel, No. 54, about 30 miles south of Nantucket, Massachusetts.—Light-ship No. 1, which has been on this station for many years, was brought to New Bedford and fitted with steam fog-signal machinery and boilers. A patent Bath ship windlass was put in, and changes were made to the oil room. She was then towed to Charleston, S. C., by the light-house tender, *Azalea*, and turned over to the inspector of the sixth light-house district. Light-ship No. 54 arrived at Woods Holl, from the contractors, on October 5, 1892, and after various alterations had been made to her riding stopper, bilge suction, feed pipes, donkey boiler, etc., on November 13 she was placed on this station. The position of the station was changed and the light-ship is now about 10 miles SW., southerly, from the old station. In April, 1893, the light-ship was brought in and hauled out of the water, when her bottom was scraped and painted, a new propeller was put on, the boat davits were raised, the piping to

Second District.

the tanks were refitted, and 25 tons of pig-iron ballast were supplied. On June 21, 1893, she resumed her station.

125. *Cross Rip light-vessel, No. 5, Nantucket Sound, Massachusetts.*—On April 10, this vessel was brought in for repairs. A new windlass was put in, the copper was renewed above the bilge keel, the stem was leaded, the deck was calked from forward to the windlass bitts, a new crane for the boat was put in and the hawse pipe and bell were repaired. On April 22 she resumed her station. Early in April an unknown schooner struck the light-ship, fortunately doing no damage, except to the paint. Early in the same month the rear barge of a tow of three struck the light-ship at 3:30 a. m., staving the small boat, disabling one davit, breaking the main rail and twisting the cathead out of place. Diligent inquiry failed to secure the name of the tug having the tow in charge. Repairs can be made on the station.

126. *Succonnessett Shoal light-vessel, No. 6, Nantucket Sound, Massachusetts.*—On June 5 this vessel was brought in for repairs to the copper, which was in bad condition, having been torn off by the ice of the previous winter. Other repairs to the stem, etc., were also made. On June 19 she was replaced on her station. The medicine chest was replenished, and galley ware was supplied.

133. *Vineyard Sound (Sow and Pigs) light-vessel, No. 41, western entrance to Vineyard Sound, Massachusetts.*—The heavy ice of last winter did not injure this vessel's copper, as it did that of most of the other light-ships. No repairs were made during the year. On June 1, at 3 a. m., the rear barge of a tow of three struck the light-ship, splitting the shoeing on the stem for a distance of 4 feet. Lumber was given the keeper, and repairs were made by him.

134. *Hen and Chickens light-vessel, No. 2, entrance to Buzzards Bay, Massachusetts.*—This vessel will be brought in for repairs to her copper. She leaks somewhat about the stem and this will be attended to at the same time. The medicine chest was replenished, the boat was repaired, and sails were supplied, during the year.

—. *Relief light-vessel, No. 9.*—This vessel's decks need calking or covering with canvas. During the year, she was on Shovelful Shoal, Cross Rip, Handkerchief and Succonnessett Shoal stations, as a relief light-vessel.

—. *Relief light-vessel, No. 39.*—A patent riding stopper was put in before she went on the Nantucket New South Shoal station.

DAY OR UNLIGHTED BEACONS.

Bird Island Beacon, southeast end of Bird Island, Boston Bay, Massachusetts.—The day-mark and spindle, which were carried away in November, 1892, were recovered and reset.

Third District.

Recommendation is made that this additional appropriation be made for that purpose.

314. Tarrytown, Hudson River, New York.—Contract was made for delivering and placing 600 tons riprap stone for the protection of the pier.

—. *Rockland Lake, Hudson River, New York.*—An appropriation of $35,000 was made at the last session of Congress for establishing a light and fog signal at this place. Soundings are now being taken preparatory to making plans and specifications for the erection of the proposed structures.

315. Stony Point, Hudson River, New York.—A new fence with necessary gates was built around the garden. Various minor repairs were made.

993. Newport Wharf, Lake Memphremagog, Vermont.—A combined oil and lamp house was built.

994. Windmill Point, Lake Champlain, Vermont.—A survey of the reservation and various minor repairs were made.

996. Isle la Motte, Lake Champlain, Vermont.—A survey of the reservation and various minor repairs were made.

997. Point aux Roches, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1000. Cumberland Head, near Plattsburg, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1002. Plattsburg Breakwater (NE.) Lake Champlain, New York.—The beacon was removed to the extreme end of the extended breakwater and various repairs were made.

1004. Bluff Point, on Valcour Island, Lake Champlain, New York.—A survey of the reservation was made.

1006. Burlington Breakwater (north extension), Lake Champlain, Vermont.—A new beacon was built.

1009. Juniper Island, Lake Champlain, Vermont.—The old wharf was remodeled and extended 80 feet; a combined boathouse and buoy shed was built on the inshore end. A survey of the reservation was made and some minor repairs on the dwelling were completed.

1010. Split Rock, near Essex, Lake Champlain, New York.—A survey of the reservation and various repairs were made.

1011. Otter Creek, Lake Champlain, Vermont.—A survey of the site for an oil house and lamp room was made.

1013. Crown Point, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1014. Watch Point, Lake Champlain, Vermont.—An oil and lamphouse combined was built.

1018. Above Pulpit Point, No. 13, Whitehall Narrows, New York.—Bids were asked for rebuilding the crib.

1019. Opposite Belden Dock, No. 12, Whitehall Narrows, Vermont.—

April the whistling buoy at the entrance to Vineyard Sound was lost. Eight new buoys were established in Chatham New Harbor.

DEPOTS.

Lovells Island, Boston Harbor, Massachusetts.—The keeper's house needs a new underpinning. A cistern should be built, as there is now a great lack of water.

Woods Holl Little Harbor, Massachusetts.—This buoy depot is in good condition with the exception of one coal shed which needs repairs. A new fence inclosing the yard will soon be needed.

Machine and lamp shop, Boston.—Extensive repairs were made to fog signals, revolving machinery and the like.

TENDERS.

The Geranium.—This tender is employed in the buoy work, etc., of the northern part of the district. In August, 1892, she was hauled out, her old metal was stripped off, the bottom was calked, and the bottom and keel were remetaled. At the same time extensive repairs were made to her wheel batteries and blow pipes. In October she was laid up and received a new boiler. The engines were lined up and repaired. A steel donkey boiler was put in at the same time. During the year she steamed 4,772 miles and consumed about 415 tons of coal.

The Verbena.—The boiler of this steamer is old and liable to give out. Her hull appears to be remarkably sound, considering her age. While the *Geranium* was laid up for a new boiler, she did all the buoy work in the northern part of the district. She came to Boston from Woods Holl in October, 1892, and returned in April, 1893. During the year she steamed 5,188 miles and consumed about 527 tons of coal.

The Azalea.—This steamer was constantly employed in the work of the southern part of the district. In November, she towed Light-Ship No. 1 to Charleston, S. C. Her boiler and engines now require a general overhauling. In January a water-tank was put in, the anchor davits and heaters were overhauled, steel boat davits were set up, the steam tram was repaired and changes were made in the arrangement of the saloon and hatchways. During the year she steamed 11,735 miles and consumed about 898 tons of coal.

The Myrtle.—This steamer, used for construction and repair, was taken out on the railway in March, 1893, and repaired; the machinery was overhauled; a chart-house was added at the after end of the main house. The hull is now in good condition. The boiler has called for more or less repairs during the whole year. It is in an unsatisfactory condition now, and a new one will have to be provided next year. A donkey boiler was set up. During the year, she steamed 13,000 miles and consumed about 700 tons of coal.

THIRD DISTRICT.

rd district includes and extends from Elisha Ledge, off War-, Rhode Island, to a point on the coast of New Jersey, oppo-rsbury Rocks, and embraces all aids to navigation on the sea l coast of Rhode Island, Connecticut, and New York, and of ey above the Highlands of Navesink; Mount Hope, Narra-ınd New York bays; Providence, Connecticut, Thames, Rari-Hudson rivers; Whitehall Narrows, and lakes Champlain and magog.

or.—Capt. Winfield S. Schley, U. S. Navy.

er.—Maj. David P. Heap, Corps of Engineers, U. S. Army.

re in this district—

es and beacon lights, including 95 post lights	237
s in position	7
s for relief	3
ighted beacons	41
s operated by steam or hot-air engines	16
s operated by clockwork	49
ioys	7
buoys in position	5
in position	18
's in position	503
rmeria, used for supplying the light-stations of the Atlantic and Gulf	1
Iohn Rodgers and *Cactus*, buoy tenders and for supply, inspection of tions, and for repair of the cables, etc., of the electric-lighted buoys	2
ardenia, buoy tender and for freight	1
ıch *Bouquet*, for attending to the electric-lighted buoys	1
Mistletoe and *Rose*, used for works of construction and repair of light-fog signals, and day beacons	2
ettle, for works of construction and repair on Lake Champlain	1

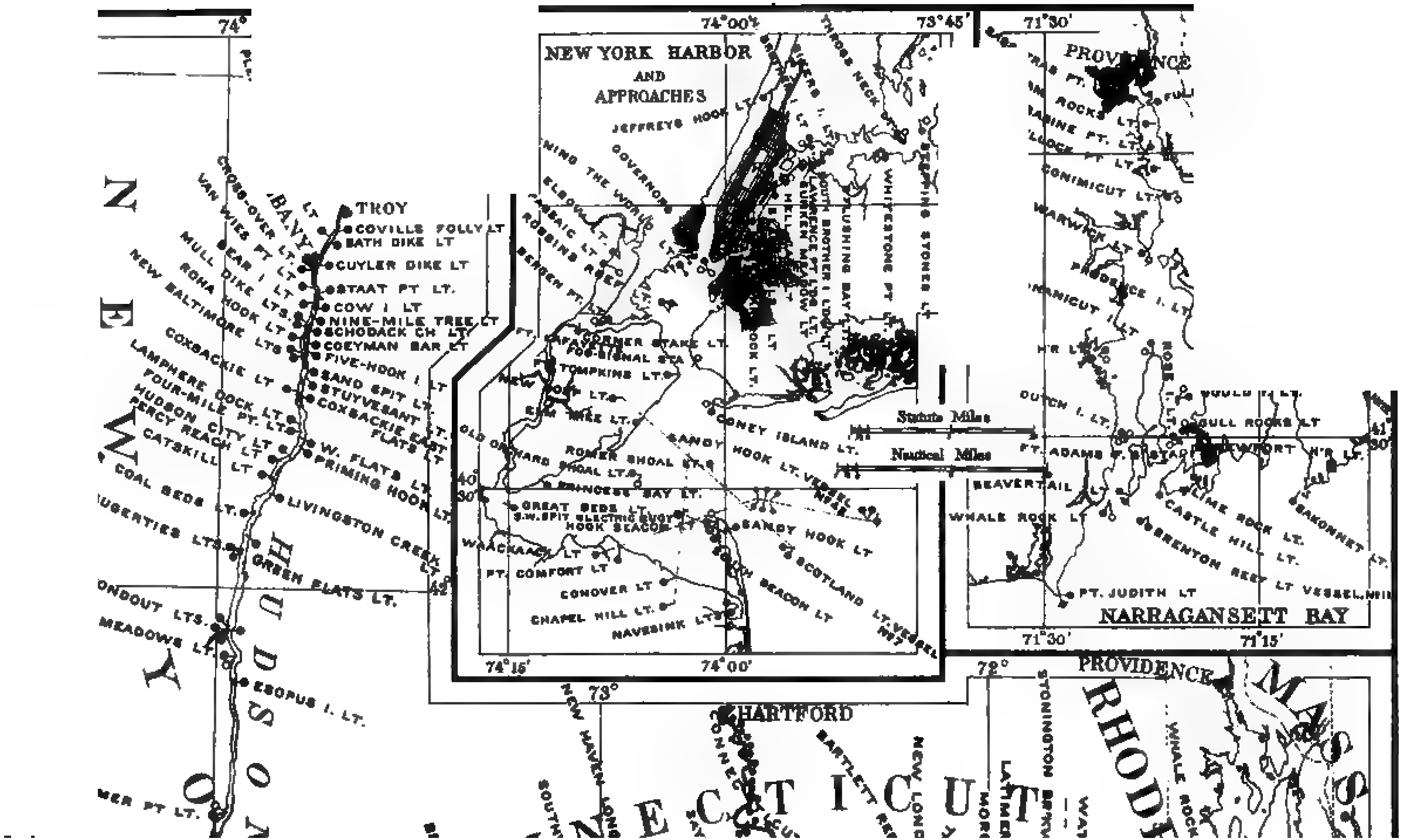
llowing lights and fog signals were established during the

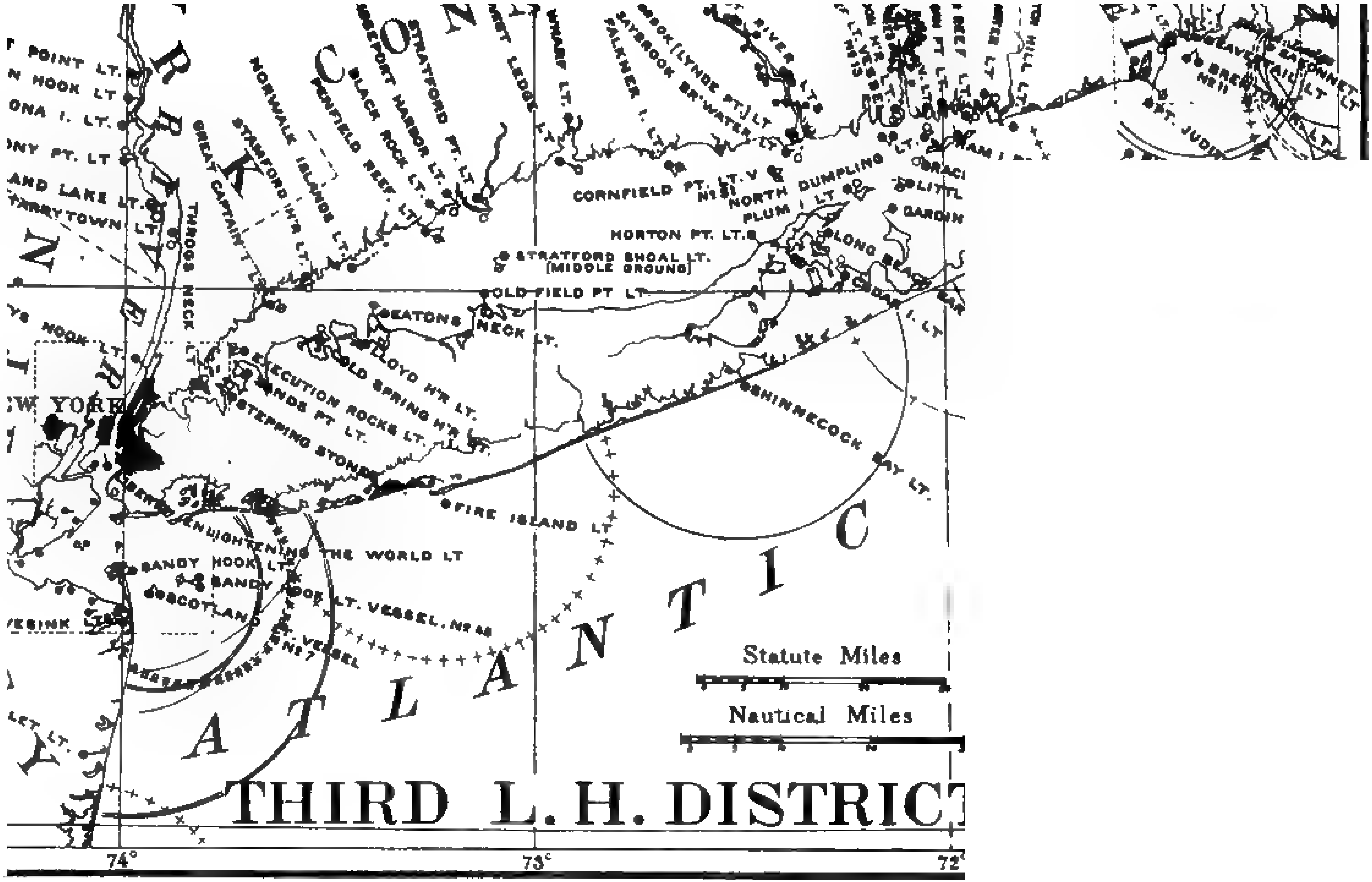
rd Shoal light-station, New York.........April 25, 1893

FOG SIGNALS.

teef, blower siren.........April 25, 1893
t Ledge, Connecticut, fog bell.........January 7, 1893

·Four stations with fog signals operated by steam or hot air also have bells machinery.


NEW YORK HARBOR AND APPROACHES
NARRAGANSETT BAY
PROVIDENCE
TROY
HARTFORD
HUDSON
NEW YORK
CONNECTICUT
RHODE
MASS
Statute Miles
Nautical Miles
COVILLS FOLLY LT
BATH DIKE LT
CUYLER DIKE LT
STAAT PT LT.
COW I LT
NINE-MILE TREE LT
SCHODACK CH LT
COEYMAN BAR LT
FIVE-HOOK I LT
SAND SPIT LT.
STUYVESANT LT.
COXSACKIE EAST FLATS LT
W. FLATS LT
PRIMING HOOK LT
LIVINGSTON CREEK LT
GREEN FLATS LT.
ESOPUS I. LT.
CROSS-OVER LT.
VAN WIES PT LT
BEAR I LT
MULL DIKE LTS.
ROHA HOOK LT
NEW BALTIMORE LTS
COXSACKIE LT
LAMPHERE DOCK LT.
FOUR-MILE PT. LTS.
HUDSON CITY LT
PERCY REACH LT
CATSKILL LT
COAL BEDS LT.
MEADOWS LT.
JEFFREYS HOOK LT.
GOVERNORS
ELBOW LT.
PASSAIC LT.
ROBBINS REEF
BERGEN PT.
CORNER STAKE LT.
FOG-SIGNAL STA
TOMPKINS LT.
OLD ORCHARD SHOAL LT.
ROMER SHOAL LT.
CONEY ISLAND LT.
SANDY HOOK LT. VESSEL
PRINCESS BAY LT.
GREAT BEDS LT.
HOOK BEACON LT
SANDY HOOK LT
SCOTLAND LT. VESSEL
WAACKAACK LT
PT. COMFORT LT
CONOVER LT
CHAPEL HILL LT.
NAVESINK LTS
STEPPING STONES LT
WHITESTONE PT LT.
FLUSHING BAY LT.
SOUTH BROTHER I LDG LT
LAWRENCE PT LDG LT.
SUNKEN MEADOW LT
THROGS NECK
CONIMICUT LT.
WARWICK LT
PRUDENCE I. LT
DUTCH I. LT.
PT. ADAMS
BEAVERTAIL LT
WHALE ROCK LT
GULL ROCKS LT
LIME ROCK LT.
CASTLE HILL LT.
BRENTON REEF LT VESSEL
SAKONNET LT.
PT. JUDITH LT
ROSE I. LT.
NEW HAVEN LONG
BARTLETT REEF
NEW LONDON
STONINGTON BRKW
LATIMER
WHALE ROCK
74°
73°
72°
74°00'
74°15'
73°45'
71°30'
71°15'
40° 30'
41° 30'
42°



THIRD L. H. DISTRICT
ATLANTIC
Statute Miles
Nautical Miles
74°
73°
72°
NEW YORK
THROGS NECK LT.
GREAT CAPTAIN I. LT.
STAMFORD H'R LT.
NORWALK ISLANDS LT.
PENFIELD REEF. LT.
BLACK ROCK LT.
STRATFORD PT. LT.
WHARF LT.
FALKNER I. LT.
SAYBROOK BR'WATER LT.
CORNFIELD PT. LT. V
NORTH DUMPLING
PLUM I. LT.
HORTON PT. LT.
STRATFORD SHOAL LT. [MIDDLE GROUND]
OLD FIELD PT LT.
EATONS NECK LT.
LLOYD H'R LT.
OLD SPRING H'R LT.
EXECUTION ROCKS LT.
SANDS PT LT.
STEPPING STONES
SHINNECOCK BAY LT.
FIRE ISLAND LT.
SANDY HOOK LT.
SCOTLAND
PT. JUDITH
TARRYTOWN LT.

Third District.

LIGHT-STATIONS.

—. *Plum Beach, Narragansett Bay, Rhode Island.*—The following recommendation, made in the Board's last annual report, is renewed:

The great Sound steamers plying between Providence, R. I., and New York, N. Y., find navigation during fog quite hazardous. In avoiding Dutch Island there is extreme danger of grounding on Plum Beach, as is shown by the recent grounding of the steamer *Pequot*. It is estimated that a proper light and fog signal can be established on Plum Beach for not exceeding $60,000, and it is recommended that an appropriation of this amount be made therefor.

155. *Conanicut Island, Narragansett Bay, Rhode Island.*—The fog-bell apparatus was overhauled and repaired. A contract was made to build a breakwater to protect the site.

156. *Wickford Harbor, on Old Gay Rock, Rhode Island.*—A contract was made for placing 600 tons of riprap stone for the protection of the pier.

161. *Warwick, on southern extremity of Warwick Neck, Rhode Island.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

A steam fog signal in duplicate is needed here. It can be established at an estimated cost of $5,000. It is recommended that an appropriation of this amount be made therefor.

175. *Watch Hill, Rhode Island.*—A wire ribbon fence 520 feet long, with the necessary gates, was built on the west, north, and east sides of the light house reservation. Various minor repairs were made. A contract was made to rebuild part and to repair the remainder of the sea wall.

181. *North Dumpling, Fishers Island Sound, New York.*—A fifth-order lens, Funck lamps, and new pedestal were substituted for the sixth-order apparatus. The fog-bell machinery was overhauled and repaired.

—. *Black Ledge, New London Harbor, Long Island Sound, Connecticut.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

The necessity for establishing a light and an efficient steam fog signal in such a position as to enable vessels to enter and leave the harbor of New London, Conn., has become evident, and especially so for the aid of those approaching from seaward.

The numerous outlying shoals and ledges surrounding the entrance to this harbor make the approach to it dangerous in thick weather. The location of the present New London light and fog-signal station is so far inside the obstructions as to be partially ineffective as an aid for the purpose of safe navigation of this entrance. The commerce of the port of New London has so increased since the erection of the present light as to change the conditions materially. In consequence of the recent grounding of the steamer *City of Worcester*, on Bartlett Reef, complaint was made that the fog bell of Bartlett Reef light-ship was not adequate to the needs of vessels approaching New London from the westward in a fog, and it was stated that Congress would be petitioned to replace the present light-ship with another carrying a steam fog signal. In view of these facts and the further fact that a naval station is in operation on the Thames River, which empties into New London Harbor, it is suggested that a light and a steam fog-signal station be established on the south-

Third District.

west ledge on the eastern side of the entrance to New London Harbor. Estimate is made that it can be done for $45,000. It is therefore recommended that an appropriation of that amount be made therefor.

204. Gardiners Island, New York.—A survey of a portion of the island was made to determine the advisability of either moving the old light and dwelling or rebuilding farther from the high-water line, which is approaching the station from the east at the rate of 10⅜ feet per year for the past three years.

206. Long Beach Bar, Gardiners Bay, New York.—Plans and specifications were prepared and bids asked for rebuilding the landing wharf destroyed by ice during the past winter.

246. Southwest Ledge, entrance to New Haven Harbor, Connecticut.—On January 7, 1893, the caloric engines and Daboll trumpet fog signal were discontinued. The machinery was removed on March 23, 1893. A new clock cord was fitted for the bell. The clock, stove-pipes, pump, doors, windows, etc., were overhauled and repaired. The establishment of a steam fog signal at Southwest Ledge light-station, at a cost not to exceed $12,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. Bridgeport Breakwater, Long Island Sound, Connecticut.—An appropriation of $2,000 was made by the act approved February 15, 1893, to establish a beacon light on the breakwater at Bridgeport. It was then supposed that the breakwater would serve as a foundation. This, as it now appears, is impracticable. A special foundation will have to be built for the beacon. It is estimated that it will cost $2,500. Recommendation is made that an appropriation of this amount be made therefor.

—. Sheffield Harbor, Long Island Sound, Connecticut.—The following recommendation, made in the Board's annual report for the last four years, is repeated:

> A large and increasing commerce now centers here. During the past year nearly 100,000 tons of coal were landed here in addition to more than that quantity of general merchandise. The New England Terminal Railway Company state that they will begin the transportation of freight in cars on the decks of car-floats and transfer steamers, and the quantity of tonnage will then be more than double. After leaving Execution Rocks light there is nothing to run them in thick weather except a buoy. It is claimed that a light placed here will render more safe the navigation at the entrances of the harbors of Sheffield and South Norwalk. It is proposed to build a small structure with a light and fog bell at the 4-foot spot off Norroaton Point, now marked by a red and black buoy. The structure should consist of an iron caisson filled with concrete, surmounted by a wooden tower to carry the light and fog bell. It is estimated that the work can be done for $10,000. It is recommended that an appropriation of this amount be made therefor.

256. Lloyd Harbor, in Huntington Bay, Long Island Sound, New York.—The breakwater, mentioned in the last annual report as under contract, was completed. The underpinning under the southwest corner of the dwelling was rebuilt and minor repairs were made.

Third District.

271. Hell Gate post light, at Hallets Point, Long Island Sound, New York.—On December 31, 1892, the characteristic of the light was changed from fixed white to an occulting red and white light every three seconds. The fog-bell apparatus was repaired.

287. Hook Beacon, on the north point of Sandy Hook, New York Bay, New Jersey.—The new fog signal was completed and put in operation December 31, 1892. Various minor repairs were made.

288. Sandy Hook fog bell, New York Bay, New Jersey.—The fog-bell tower on the west point of the Hook was moved south about 55 feet and placed on a new foundation.

293. Point Comfort Beacon, Bayside, New York Bay, New Jersey.—A survey of the reservation was made to determine the feasibility of moving the dwelling and tower.

294. Waackaack, New York Bay, New Jersey.—The old tower was removed toward and on the range of Point Comfort 52 feet; piers were completed to receive the skeleton iron tower. Various repairs were made.

295. Old Orchard Shoal, Lower Bay, New York.—This station was completed and lighted April 25, 1893.

298. Princess Bay, on Staten Island, New York.—The bridge across the small creek north of the light-station, carried away by the ice during the last winter, was rebuilt. Various repairs were made.

305. Fort Tompkins, on Staten Island, New York.—The revolving apparatus was repaired and some material for other repairs was delivered. The following recommendation made in the Board's last annual report is renewed:

> The light at Fort Tompkins at present is well back of the point it is intended to mark. It is therefore proposed to move it from there to an angle of the stone fort at Fort Wadsworth, where it will better serve as a mark to the channel leading directly into New York Harbor. A fog signal at Fort Wadsworth would be of especial service to the large commerce going through the Narrows during thick weather. The fog bell at Fort Lafayette is serviceable to vessels bound to Coney Island, but it is too distant to be of much use to vessels using the other and more frequented side of the channel. The change will make it necessary to build a lantern and watchroom on the salient of the fort and to place a fog-signal house and apparatus at the foot of the wall. It is estimated that these changes can be made for not exceeding $1,500, and it is recommended that an appropriation of this amount be made therefor.

306. Robbins Reef, New York Harbor, New York.—The iron landing platform was renewed. A blower siren was installed and put into operation on April 25, 1893. An oil house of the capacity of fifty boxes was built.

307. The Statue of Liberty Enlightening the World, Bedloes Island, New York Harbor, New York.—The bridge walls of the boilers were rebuilt and various minor repairs were made. The roof of the entire building was painted with asphalt paint. The following recommendation, which was made in the Board's last five annual reports, is renewed:

> Fifty thousand dollars is needed for finishing the pedestal of this statue, which, by act of Congress, has been placed under the care of the Light-House Board.

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Recommendation is made that this additional appropriation be made for that purpose.

314. Tarrytown, Hudson River, New York.—Contract was made for delivering and placing 600 tons riprap stone for the protection of the pier.

—. *Rockland Lake, Hudson River, New York.*—An appropriation of $35,000 was made at the last session of Congress for establishing a light and fog signal at this place. Soundings are now being taken preparatory to making plans and specifications for the erection of the proposed structures.

315. Stony Point, Hudson River, New York.—A new fence with necessary gates was built around the garden. Various minor repairs were made.

993. Newport Wharf, Lake Memphremagog, Vermont.—A combined oil and lamp house was built.

994. Windmill Point, Lake Champlain, Vermont.—A survey of the reservation and various minor repairs were made.

996. Isle la Motte, Lake Champlain, Vermont.—A survey of the reservation and various minor repairs were made.

997. Point aux Roches, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1000. Cumberland Head, near Plattsburg, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1002. Plattsburg Breakwater (NE.) Lake Champlain, New York.—The beacon was removed to the extreme end of the extended breakwater and various repairs were made.

1004. Bluff Point, on Valcour Island, Lake Champlain, New York.—A survey of the reservation was made.

1006. Burlington Breakwater (north extension), Lake Champlain, Vermont.—A new beacon was built.

1009. Juniper Island, Lake Champlain, Vermont.—The old wharf was remodeled and extended 80 feet; a combined boathouse and buoy shed was built on the inshore end. A survey of the reservation was made and some minor repairs on the dwelling were completed.

1010. Split Rock, near Essex, Lake Champlain, New York.—A survey of the reservation and various repairs were made.

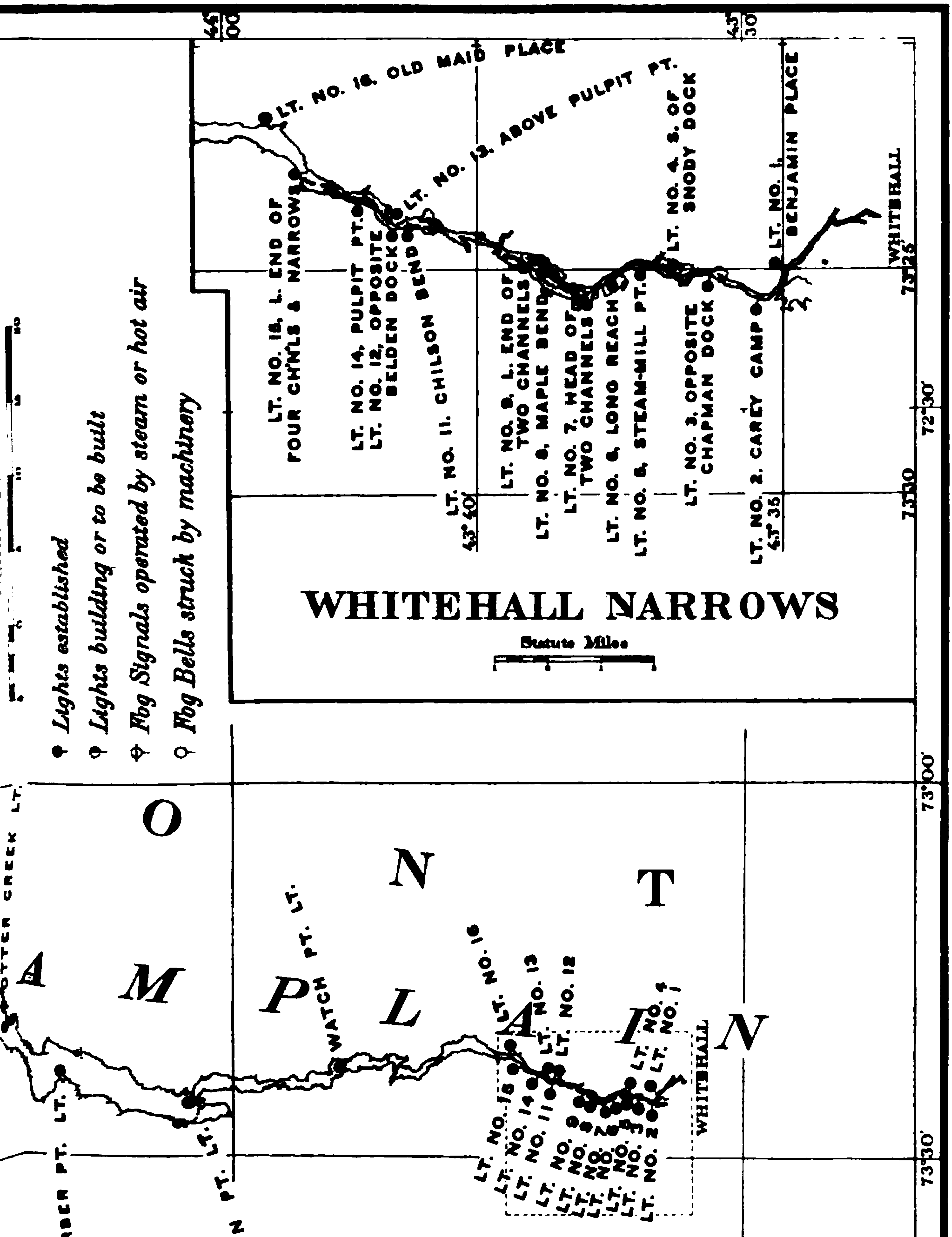
1011. Otter Creek, Lake Champlain, Vermont.—A survey of the site for an oil house and lamp room was made.

1013. Crown Point, Lake Champlain, New York.—A survey of the reservation and various minor repairs were made.

1024. Watch Point, Lake Champlain, Vermont.—An oil and lamphouse combined was built.

1028. Above Pulpit Point, No. [illegible], Whitehall Narrows, New York.—Bids were asked for rebuilding the crib.

1029. Opposite Ridden Dock, No. [illegible], Whitehall Narrows, Vermont.—



Lights established
Lights building or to be built
Fog Signals operated by steam or hot air
Fog Bells struck by machinery
WHITEHALL NARROWS
Statute Miles
LT. NO. 16, OLD MAID PLACE
LT. NO. 13, ABOVE PULPIT PT.
LT. NO. 4, 5, OF SNODY DOCK
LT. NO. 1, BENJAMIN PLACE
WHITEHALL
LT. NO. 15, L. END OF FOUR CH'NLS & NARROWS
LT. NO. 14, PULPIT PT.
LT. NO. 12, OPPOSITE BELDEN DOCK
LT. NO. 11, CHILSON BEND
LT. NO. 9, L. END OF TWO CHANNELS
LT. NO. 8, MAPLE BEND
LT. NO. 7, HEAD OF TWO CHANNELS
LT. NO. 6, LONG REACH
LT. NO. 5, STEAM-MILL PT.
LT. NO. 3, OPPOSITE CHAPMAN DOCK
LT. NO. 2, CAREY CAMP
43° 40'
43° 35'
73°25'
73°30'
72°30'
73°00'
43° 00'
43° 30'
O N T
A M P L A I N
Y O R K
OTTER CREEK LT.
WATCH PT. LT.
BARBER PT. LT.
CROWN PT. LT.
LT. NO. 16
LT. NO. 13
LT. NO. 12
LT. NO. 4
LT. NO. 1
LT. NO. 15
LT. NO. 14
LT. NO. 11
LT. NO. 9
LT. NO. 8
LT. NO. 7
LT. NO. 6
LT. NO. 5
LT. NO. 3
LT. NO. 2
WHITEHALL

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A new lower section in the north side of the beacon was made and fitted and bids were asked for rebuilding the crib.

1020. Chilson Bend, No. 11, Whitehall Narrows, New York.—A new lower section in the north face of the beacon was made and fitted and bids were asked for rebuilding the crib.

1021. Lower end of Two Channels, No. 9, Whitehall Narrows, New York.—Bids were asked for rebuilding the crib.

1022. Maple Bend, No. 8, Whitehall Narrows, New York.—A new lantern box was made and set up.

1026. South of Snody Dock, No. 4, Whitehall Narrows, Vermont.—Bids were asked for rebuilding the crib.

REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

144. Sakonnet, R I.
146. Beavertail, R. I.
147. Castle Hill, R. I.
148. Fort Adams, R. I.
149. Lime Rock, R. I.
150. Newport Harbor, R. I.
151. Rose Island, R. I.
152. Dutch Island, R. I.
153. Gull Rocks, R. I.
159. Muscle Bed Shoals, R. I.
160. Bristol Ferry, R. I.
161. Warwick, R. I.
162. Borden Flats, Mass.
163. Conimicut, R. I.
164. Bullock Point, R. I.
165. Sabine Point, R. I.
166. Pomham Rock, R. I.
168. Sassafras Point, R. I.
169. Whale Rock, R. I.
170. Point Judith, R. I.
171. Block Island (N.), R. I.
172, 173. Block Island Range, R. I.
174. Block Island (SE.), R. I.
176. Montauk Point, N. Y.
177. Stonington Breakwater, Conn.
178. Latimer Reef, N. Y.
182. New London Harbor, Conn.
—— New London buoy wharf, Conn.
202. Race Rock, N. Y.
203. Little Gull Island, N. Y.
205. Plum Island, N. Y.
207. Cedar Island, N. Y.
208. Saybrook Breakwater, Conn.
209. Saybrook Point, Conn.
245. Falkner Island, Conn.
247. New Haven Long Wharf, Conn.
248. Stratford Point, Conn.
249. Stratford Shoals, Conn.
251. Bridgeport Harbor, Conn.
252. Black Rock, Conn.
253. Penfield Reef, Conn.
255. Eatons Neck, N. Y.
258. Stamford Harbor, Conn.
259. Great Captain Island, N. Y.
260. Execution Rocks, N. Y.
267. North Brother Island, N. Y.
272. Man-o'War Rock post light, N. Y.
273. Shinnecock Bay, N. Y.
274. Fire Island, N. Y.
277, 278. Navesink, N. J.
285. Sandy Hook, N. J.
291. Conover Beacon (front), N. J.
296. Elm Tree Beacon (front), N. Y.
299. Great Beds, N. J.
303. Coney Island, N. Y.
309. Bergen Point, N. J.
311. Passaic, N. J.
318. West Point, N. Y.
321. Esopus Meadows, N. Y.
322. Rondout, N. Y.
327. Saugerties, N. Y.
332. Hudson City, N. Y.
334. Four-Mile Point, N. Y
338. Stuyvesant, N. Y.
1004. Bluff Point, N. Y.
1005. Colchester Reef, Vt.
1012 Barber Point, N. Y.

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LIGHT-SHIPS.

145. Brenton Reef light-vessel, No. 11, entrance to Narragansett Bay, Rhode Island.—This vessel is in fairly good condition. She received, during the year, rope, oars, hose, cooking utensils, fire brick, paint, and fuel. She is kept clean and neat, and is in good order.

158. Hog Island Shoal light-vessel, No. 12, Narragansett Bay, Rhode Island.—The following recommendation, made in the Board's last annual report, is renewed:

> It is now found that she is structurally weak from general decay, induced by her old age, and that she is completely beyond economical repair. While she has been quite useful in her position, it has become apparent that she could have been of still greater use to the enormous commerce passing this point if she had had a steam fog signal. No attempt has been made to fit one to her, as she is too small and too weak to carry the weight and support the strain. The time has now come to replace this small, weak, worn-out old vessel by a new, strong ship of at least double her size and strength, not only to occupy this station, but, in its turn, to take its place on the outside exposed stations. It is also proposed that she shall have such steam power as will not only operate a first-class fog signal, but will enable her to get on and off her station with her own steam, and also steam up to its moorings when otherwise she would be blown away from her place, dragging her anchor or parting her chain cables.
>
> It is estimated that such a vessel can be built for $70,000, and it is recommended that an appropriation of that amount be made for this purpose.

She will need only a few repairs to remain on her station for the current year. The vessel received during the year cooking utensils, rope, paint, provisions, and fuel.

179. Ram Island Reef light-vessel, No. 19, Fishers Island Sound, in Long Island Sound, New York.—This vessel was rebuilt in 1876. Since then no repairs of importance have been made. A large expenditure would be required to make her efficient for service. She is kept clean and in good condition. She received during the year rope, paint, lime, and fuel.

201. Bartlett Reef light-vessel, No. 13, off New London, Long Island Sound, Connecticut.—This vessel is in need of extensive repairs, at a cost, probably, of $2,500. She is kept in good order. She received during the year ship chandlery, paint, lime, pumps, mast bands, cooking utensils, bedding, fire brick, provisions, and fuel.

215. Cornfield Point light-vessel, No. 51, off the mouth of the Connecticut River, Long Island Sound, Connecticut.—Light-vessel No. 23 was taken off this station and towed to the depot at New London on December 15, 1892. Light vessel No. 51 was moored about $\frac{5}{8}$ mile S. $\frac{3}{8}$ W. from the position occupied by the old ship. No. 51 is a steam self propelling light-vessel, and has a 12 inch steam whistle for use in thick or foggy weather. She shows simultaneously, from four lens lanterns encircling the main masthead, a fixed white electric light during periods of 12 seconds, separated by eclipses of 3 seconds' duration. The

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identification of the vessel by her characteristics is simplified by the fact that in each minute her light becomes visible four times and her fog signal sounds four blasts. She has thus all the advantages of modern improvement. Her electric light has given complete satisfaction to navigators, and the plant is skillfully operated. She can travel with her own steam and stand up to her moorings during gales. She was built at West Bay City, Mich., and reached the light house depot, Staten Island, on July 26, 1892. Here she received her illuminating apparatus, her fog-signal machinery was put in working order, and her outfit and equipment were made complete. The engine and boiler are in good condition, but several small improvements are needed. This vessel received during the year electric supplies, engineer's tools, medicines, lamps, hose, bedding, provisions, and fuel.

275. Sandy Hook light-vessel, No. 48, off the entrance to New York Harbor, New York.—This vessel is in good condition. She was removed from her station for repairs on November 16, 1892, and replaced January 16, 1893. The repairs consisted of placing alongside one boiler an iron pipe for receiving the exhaust from the steam heaters, putting in boat booms and cleats, and calking and painting the main deck. She received during the year engineer's stores, brushes, booms, paints, gaskets, provisions, and fuel.

276. Scotland light-vessel, No. 7, off Sandy Hook, entrance to New York Bay, New York.—On December 29, 1892, the Italian bark *Chiarina*, in tow of the tug *Seeking*, ran into the Scotland light-vessel and slightly damaged the top of the stem and the starboard cat head. The repairs were made by the crew of the vessel, by whom, also, was patched the metal torn off by ice, except a small inaccessible space under the hawse pipe. She received during the year ship chandlery, a new caboose, blocks, bedding, rope, paint, tools, metal, pumps, provisions, and fuel.

—. *Relief light-vessel No. 20.*—This vessel is at the light-house depot, New London, Conn. She needs to be docked and repaired, at an expense of about $1,500. The vessel received during the year paint, a pump, hose, and ship chandlery. She is kept in good order.

—. *Relief light-vessel No. 23.*—This vessel is at the light-house depot, New London, Conn. On December 15, 1892, she was taken off the Cornfield Point station, where she was relieved by the new steam light-ship No. 51, and towed to the depot. She is in good order. On the station she received paint and ship chandlery. As a relief ship her expenses were nominal.

—. *Relief light-vessel No. 16.*—This vessel is kept at the general depot, Staten Island, in readiness for the special service of relieving the Sandy Hook light-ship and for general service elsewhere. She was in service at Sandy Hook from November 16, 1892, to January 16, 1893, in place of light-ship No. 48, which was brought in for repair. For the

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special service she has all the illuminating apparatus and steam fog-signal machinery needed to make her a counterpart of light-vessel No. 48; while for general service the necessary changes would be promptly made by the force at the depot. She is kept in good condition. She received during the year pumps, paints, deck lights, new sails, and ship chandlery.

DAY OR UNLIGHTED BEACONS.

Oyster Pond Point Beacon.—The day-mark at this place was reëstablished by building an iron cylinder measuring 4 feet by 10 feet filled with concrete, surmounted by a mast and square cage painted red, 30 feet above mean high water.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

146. Beavertail, Rhode Island.—The 10-inch steam whistle, with Crosby automatic signal, was in operation about 433 hours during the year and consumed some 52 tons of coal.

170. Point Judith, Rhode Island.—The first-class steam siren, in duplicate, was in operation about 729 hours during the year and consumed some 55½ tons of coal.

174. Block Island (southeasterly), Rhode Island.—The first-class steam siren, in duplicate, was in operation about 724 hours during the year and consumed some 42½ tons of coal.

176. Montauk Point, New York.—The first-class Daboll trumpet, worked by caloric engines in duplicate, was in operation about 524 hours during the year and consumed some 5 tons of coal.

182. New London Harbor, Connecticut.—The first-class Daboll trumpet, in duplicate, was in operation about 606 hours during the year and consumed some 8 tons of coal.

203. Little Gull Island, New York.—The second-class steam siren, in duplicate, was in operation about 530 hours during the year and consumed some 33 tons of coal.

245. Falkner Island, Connecticut.—The 10-inch steam whistle, in duplicate, was in operation about 518 hours during the year and consumed some 39 tons of coal.

246. Southwest Ledge, Connecticut.—The second-class Daboll trumpet, in duplicate was in operation until January 27, 1893, for 93 hours, and consumed one-third of a ton of coal. The signal now at that station is a bell.

249. Stratford Shoals (Middle Ground), New York.—The second-class Daboll trumpet was in operation for 675 hours during the year and consumed some 4¾ tons of coal.

253. Penfield Reef, Connecticut.—The Daboll trumpet, in duplicate, was in operation 467 hours during the year and consumed some 3½ tons of coal.

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255. Eatons Neck, New York.—The second-class steam siren, in duplicate, was in operation about 482 hours and consumed some 36½ tons of coal.

259. Great Captain Island, New York.—The 10-inch steam whistle, Crosby automatic, in duplicate, was in operation about 343 hours during the year and consumed some 27½ tons of coal.

260. Execution Rocks, New York.—The automatic siren, in duplicate, was in operation about 368 hours during the year and consumed some 35 tons of coal.

287. Hook Beacon, Sandy Hook, New Jersey.—The automatic siren, in duplicate, was in operation about 773 hours during the year and consumed some 86½ tons of coal.

306. Robbins Reef, New York.—The blower siren was in operation about 94 hours and consumed two-thirds of a ton of coal from April 25, 1893. During the former part of this year a bell was used at this station.

BUOYAGE.

The cold weather of the past winter was more severe and of longer duration than it had been for many years. As a consequence, there was a continuance of heavy floes of ice through the various routes of navigation in the district. The iron buoys were removed in time and spar buoys were set in place of them. Many of the latter were swept away by ice, but they were mostly recovered by the tenders, although the action of the floes, setting in and out with the tides, kept the vessels constantly at work. The loss caused by the ice was $5,064.43, a comparatively small amount. Several light-stations were so blockaded by ice that the keepers were unable to procure supplies. In such cases the light-house steamers were able to do good service by going to their relief. The winter service was unusually hard upon these steam tenders, and such repairs as are needed will be largely due thereto. There were seven ordinary buoys discontinued during the year, and ten new ones were added to the list. In September, 1892, the establishment was able to contribute to the measures taken by the National and State governments for the preservation and protection of the public health, then seriously menaced by the arrival of vessels infected with Asiatic cholera, by coöperating with the health officer of the port of New York in placing yellow buoys to mark the quarantine anchorage and limits in the Lower Bay, thus giving public notice of the positions and purposes of the buoys.

279–284, 289. Gedney Channel Electric-Buoy Station, entrance to New York Bay.—The system of electric buoys in Gedney Channel and at Southwest Spit, New York Lower Bay, was established in 1889. The extreme cold of the past winter gave opportunity for such a test as had been desired since they were put in place; a test which should

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determine their availability as permanent aids to navigation. It was severe and crucial. The ice floating in and out of the lower bay, during the whole winter, was heavier and more continuous than for many years before. The spar buoys which support the electric lamps were frequently submerged for long intervals. During this time the lamps were broken and the buoys could not be reached. Hence it was found necessary to extinguish the lights during the continuance of the heavy winter ice. After due public notice, the electric buoys were left unlighted from January 12 until March 8, 1893, when they were again put into active operation. From this experience, it is evident that the electric buoys for Gedney Channel cannot be maintained when thick ice drifts through the channels of the lower bay. But a season of such heavy ice is exceptional. As the navigation of the channels by night during winters of this sort is always dangerous and is practically suspended, the extinguishment of the electric buoys at such times will not cause loss or accident to vessels. On the other hand, the vast benefit which they confer on navigation during at least 85 per cent of the whole year is a conclusive argument in favor of their retention as permanent aids to navigation. Each of the lights failed at one time or another, but repairs were made at once by one of the light-house tenders, or by the steam launch which was attached to the station during the summer months. The causes of failure were defects in parts of the cables, by breakage of lamps by the ice, or by collisions with passing vessels. The defects were not in the system, but in the details; such, for instance, as the covering of the cables at the points where they are connected to the buoys, defective splices, or imperfect lamps, all of which can be easily remedied in the newer developments. In one instance, the buoy of No. 4 light had been run down and the lamp destroyed by a passing vessel. In three cases new juniper buoys were supplied to take the places of those long exposed. The boilers at the light-station were cleaned and repaired several times during the year, the engines and dynamo were overhauled, and the entire plant, buildings, and supplies received careful attention. They are now in fairly good condition. The tenders did the work required of them in an efficient manner, directed by their masters in the ordinary repairs, and supervised by the assistants to the inspector where expert information was required.

For service at this station during the present year, there are on hand:

	Feet.
Single armored, single conductor cable	2,205
Double armored, single conductor cable	16,240
Double armored, three conductor cable	15,280

The steam boilers at this station are not powerful enough, when used singly, to supply the power needed to run the lights. As it has been the practice to use both boilers at rather high pressure, and at

the same time, there is no duplicate boiler upon which to rely in case of accident.

The experience acquired in devising a plan, procuring materials, putting the plant in position, and observing in successful operation the system for lighting the water front at Chicago, Ill., can be employed to improve, with slight change and adaptation, the system of lighting the electric buoys in the neighborhood of Sandy Hook. It is expected that such changes and substitutions will be made in the near future as will reduce the expense of maintenance and increase largely the efficiency of the lights now used in the lower bay.

CHICAGO FAIR BUOYAGE.

When the Light House Board decided to light by electricity the World's Fair front at Chicago, the inspector of the third light-house district was directed to devise the plan, provide the materials, and put the system adopted into operation. The system finally adopted provided fourteen juniper spar buoys, 50 feet long, prepared and fitted like the electric buoys in Gedney Channel, New York Bay, with the necessary sinkers and shackles, the 100 candle power incandescent lamps, with guards; single armored, single-conductor, submarine cable, 13½ miles long, to connect with the buoys; the necessary attachments of converters, lightning arresters, fuse boxes, switches, switch board, and the like. The cable was made, laid, and operated experimentally, under agreement with the contractors, for forty-eight consecutive hours. The converters, arresters, and other auxiliary parts of the plant were purchased, and the lamps were bought in the open market. The electric current was furnished by the World's Fair to the outer end of the Casino wharf. The buoys, guards, and appendages were shipped from the general light-house depot. The work was pushed rapidly to completion. The buoy plant was successfully operated and brilliantly lighted for the first time on the night of July 1, 1893, by the direct current, arc series, incandescent system, with Bernstein lamps. As located and lighted, the system in operation is brilliant and entirely successful, and is among the important new features of electric development exhibited. Lieut. Commander West's report, in an appendix to this report, gives a detailed description of the system employed in the Chicago buoyage, with its cost and drawings. By the application of experience gained from the electric-lighted buoys in Gedney Channel, New York Bay, and by the exercise of economy a small balance from the appropriation of $20,000 made by Congress was saved from the maintenance of the lights.

DEPOTS.

Staten Island, New York.—This depot is the purchasing, receiving, and distributing center for the general supplies needed by the entire

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Light-House Establishment. A large force and much labor are needed to carry on its work properly. Here are received, set up, and tested all the lenses and clockwork coming from abroad; here is made all the clockwork for driving the smaller lenses of the service and for furnishing the characteristics of the sound signals; here are made all the reflectors required for light-ships, all the lamps, burners, and supports required for the vessels and shore stations of the establishment, all the lanterns for the light-vessels, all the cans in which oil is furnished to all vessels and stations; here are made all repairs of importance to illuminating apparatus; here are delivered all the can, nun, bell, and whistling buoys furnished to the establishment, with their chains, sinkers, ballast-balls, anchors, etc.; here is set up and tested all fog-signal machinery. All general supplies, such as oils, wicks, chimneys, paints, ropes, canvas, tools, and hundreds of other articles are bought under contract and delivered at this depot. Here everything received is tested, weighed, or measured and approved before acceptance for the general service; here they are stored and hence they are issued. The large quantities of each article furnished allow of its being supplied at a figure far below what it would cost were its purchase made separately for each district. The tests applied by experts to every purchase insure the satisfactory quality of all articles obtained. Were it practicable to present in detail a year's operations at this depot no further argument would be needed to set forth its usefulness and its value.

All this work requires intelligence and skill. But neither intelligence nor skill can overcome wholly defects which are inherent in the place where the work is done. The lamp shop is overloaded with work; the storehouses are crowded beyond their capacity; the grounds are encumbered to an extent which impedes easy movement. These defects mean that the establishment is steadily running behind because the depot can not keep up with its demands; they mean that materials must be moved and removed, that supplies must be handled and rehandled, and hence that much money is wasted. The need for enlarging the facilities of the depot for the reception, handling, and care of supplies, oil, and other stock is more pressing every year. Now, it is necessary to provide better accommodations. The storehouse was built in 1864, when space was required for only 2,600 packages of supplies of all kinds. In 1885 the number of packages stored was 5,600. In 1891 space had to be made by building tiers and overcrowding for 7,800 packages. These last figures do not include packages containing paints, paint oil, chimneys, etc., which are stored in buildings apart from the main storehouse. The number of packages stored in 1892 amounted to 8,100. The steady increase in the volume of business done at the depot is shown by the fact that 8,500 packages were stored here in 1893. While the demands of the service have grown, this depot has remained with-

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out addition. The oil house on the dock was built in 1881, and held with safety 25,000 cases of mineral oil. Storage is now required for 60,000 cases. It is proposed to remove the coal sheds from their present site to the southern end of the water front, and then to enlarge the oil house to an ample size, and strengthen it for use in every part. The storehouse proper should be enlarged to nearly twice its present size, which would require the removal of its adjuncts to other sites. One of these would require the ground occupied by the small house near the north wharf, now used by the Revenue Marine as a receptacle for condemned stores. In any event, the space so occupied is needed for the depot, where every foot is indispensable for the work to be done. The storehouse occupied by the Revenue Marine is used merely to hold dunnage and refuse. It is badly out of repair and should be cleaned out in the interests of health. Every available inch of ground is needed for light-house purposes; and this building should be cleared out and turned over to the inspector for light-house use in storing many things now under contract that are not delivered because of want of room at the station.

A new steam fire engine has been bought, an engine house has been built, and a fire department, composed of the employés of the depot, has been organized, equipped, and drilled for service in time of need.

The station is dependent for light upon an electric plant outside the grounds. If this should fail to do its work, the depot would be without light. It should be lighted by its own plant. There is steam power enough here for the purpose, and it would only be necessary to purchase two dynamos and the necessary switchboard and other connections to do the work. The houses, offices, shops, etc., are now all wired. The safety, security, and increased efficiency of lighting afforded by the electric system, even though at a small increase of expense over older methods, seems to justify the establishment of our own electric plant at this depot. The public property stored at the depot is vast and valuable, and needs the most effective means for its protection.

The service of the office and the work of the depot were as well done as the lack of facilities at the station would permit.

The work done during the past year under the inspector consisted of receiving and testing oils, paints, and chimneys; inspecting and weighing provisions and general stores; repairing buoys, tenders, and boats; making and repairing sails, awning, and canvas covering; receiving, storing, and shipping general and incidental supplies, buoys, and appendages, light-vessel equipments, rations, and fuel; loading and unloading the supply steamer and the tenders; and improving and perfecting, so far as might be, the resources and system of a depot from which the establishment is supplied.

The work done by the light-house engineer consists of manufacturing and repairing lamps, supplies, fitting illuminating apparatus, making

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oil cans and boxes for supplying oil to light-stations, manufacturing light-house and light-ship lanterns, receiving material for manufacturing and repair work, repairing light-houses, oil houses, and other structures, repairing buoys, and appendages, and general works of repair in the district.

A creditable display of lenses, lamps, etc., was prepared and sent to the Columbian Exhibition at Chicago, Ill.

A suitable engine house for the reception and care of the portable fire engine has been built.

The dredging and removal of the reef in the northwest corner of the basin were completed, and the north arm of the north wharf was built out to its junction with the east face. The coal bulkhead wharf was extended north to the north wharf. The south wharf and runway were repaired, and snubbing posts were driven along the east face of the old north wharf. Soundings were taken on the lines of the proposed enlarged basin, and on the southward extension of the bulkhead wharf to the American Cotton Docks. Plans and specifications were prepared and, after advertising for bids, a contract was made for building the sea wall of the east face of the new south wharf.

The following is a list of the improvements needed at this depot, with their estimated cost. They are arranged in the order of their necessity.

Extension to lamp shop	$24,000
New elevator	3,000
New boiler room	2,500
New engine, in place	3,000
New boiler, in place	2,000
Additional shafting	500

WHARVES AND BASIN.

South sea wall	$50,000
South wharf	15,000
Dredging basin and removing old wharves	15,000
Bulkhead and filling	40,000
Coal wharf	5,000

ADDITIONAL BUILDINGS.

Coal shed	$5,000
Hoisting machinery	1,600
New oil house	20,000
Engineer's storehouse	3,000
Extending blacksmith shop	1,500

It is estimated that improvements to the extent of $75,000 are urgently needed during the coming year, and it is recommended that an appropriation of at least this amount be made therefor.

New London, Conn.--There is kept at this depot a stock of buoys and appendages, chain cable, anchors, and fuel for general serv-

ice, together with oil, lime, and cleansing materials sufficient for emergencies. The steam tender *Cactus* is stationed here, her work being chiefly in the eastern section of the third light-house district. There are now two relief light-ships at this depot, No. 20 for ordinary stations, and No. 23 especially for duty at Cornfield Point. The old water-pipes were taken up and new pipes were laid from the street main and extended. The depot is now in good order.

Goat Island, Newport Harbor, Rhode Island.—Coal is kept at this depot for the stations in the vicinity, and for the tenders when working in the eastern section of this district. Buoys and appendages, light-ship chain and anchors are kept on the wharf for emergencies. The planking of the wharf is being renewed, and when this is done the depot will be in good condition. A few improvements for keeping the buoys will be made.

Juniper Island, Lake Champlain, Vermont.—This is now a good depot for buoys, boats, and supplies. Under the act of Congress, of March 3, 1891, making an appropriation for the purpose, the wharf was rebuilt and extended about 80 feet, and a shed for boats and buoys was built at its inner end:

TENDERS.

The Armeria.—This supply steamer was employed from August 1 to September 24, 1892, in delivering annual supplies to the light-stations from St. Croix River, Maine, to North Brother Island, New York. On her trip from December 5, 1892, to March 19, 1893, she supplied the stations between Cape Lookout, North Carolina, and Point Isabel, Texas. On the third voyage, from May 15, 1893, to July 3, 1893, she supplied the stations between Cape Henry, Virginia, and Robbins Reef, including the Hudson River, New York. In performing this service, the *Armeria* steamed 14,500 miles of continuous travel and consumed 1,169 tons of coal. Her deliveries embraced 249,000 gallons of mineral oil, 230 tons of paints, oils, and turpentine, 3,750 boxes of chimneys and supplies, and 10,370 packages of cleaning materials and miscellaneous stores. She landed, at the different district depots, 300 tons of chain, shackles, ballast balls, and incidental supplies, and furnished transportation and assisted in such local work as the district officers required. The services of this vessel are of the first importance to the establishment, and are always performed carefully and well, while she herself continues to prove that she is well adapted for her special work. The prevalence of dense fogs, when the vessel was at work on the New England coast, made navigation difficult; but, beyond the fact that, in landing in the surf at the coast lights and crossing shoal-water bars in heavily laden boats, the service was extra hazardous, there is no incident of special note in the history of the vessel for the past year. She needed few repairs and they were made by the force at the depot. Her present

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condition is good. She is to receive new water tanks and a circulating pump. She is kept in excellent order and in good discipline. She received, during the year, engineer's stores, electric supplies, crockery, medicines, ship chandlery, provisions, and fuel.

The John Rodgers.—This steamer was off duty for repairs only nine days during the year. The heavy ice, moving through the bays and harbors of the district, kept her and the other tenders constantly busy during the winter replacing and recovering buoys. During the year she steamed about 11,155 miles and consumed 702 tons of coal. She changed or replaced 329 buoys, painted 283, and recovered 32; delivered 411 tons of coal and 143 packages of supplies; made 62 shipments of freight, and inspected 108 stations. She was employed 59 days in attending to the electric buoys at Sandy Hook, 25 days in changing and serving light-ships, 10 days filling the gas tanks at Romer Shoal beacon, and 70 days at the general depot, storing supplies, preparing shipments, and painting buoys. The other working days of the year were given to buoy service, delivering supplies, marking wrecks, and attending to post lights. She assisted in buoying the channels for the great naval parade in April, 1893. Her work was well done, and she is kept in excellent order. A new boiler for this tender is now nearly completed. During the year she was furnished with cooking utensils, engineer's stores, bedding, carpets, ship chandlery, provisions, and fuel.

The Cactus.—This steamer received a new boiler, a steam steerer and minor repairs, in the early part of the year, and, in consequence, was off duty for 47 days. She was employed for a week in connection with the naval parade of the Columbian celebration, and another week in placing buoys in Long Island Sound for the trial trip of the U. S. S. *Machias*. For the rest of the year she was constantly employed, the heavy ice of the winter adding largely to her duties. She steamed 8,495 miles and consumed 499 tons of coal; changed or replaced 256 buoys; delivered 569 tons of coal, 25 cords of wood, and 33 barrels of lime; made 244 inspections of lights, 176 shipments of supplies, and 37 deliveries of rations and stores. The buoys and appendages kept at the New London and Newport depots were cleaned, repaired, and painted by the crew of the vessel. She is kept in good order. The hull of the vessel is in good condition. She will be furnished with a new whaleboat. In the engineer's department, the boiler will receive soft patches and eight new socket bolts; the lower joint of the cylinder will be repaired, and the valve chests, in use since 1869, will be repaired or renewed, as may be found best after examination of them on the inside. Her incidental supplies during the year were principally a new boiler, cooking utensils, engineer's stores, a new steam steerer, carpets, fire brick, ship chandlery, provisions, and fuel.

The Gardenia.—This steamer was laid up 44 days for repairs, which consisted in giving her a new boiler, overhauling her engine, extending

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her deck house aft 6 feet, to make a mess room for the officers, calking the forward deck and putting new sheathing on it, and cleaning and painting her bottom. For the rest of the year, her regular work and the extra service caused by the ice kept her constantly on the move. She placed or replaced 209 buoys and cleaned and painted 205; repaired the cables and lamps of the electric buoy system, at Sandy Hook, twenty times; made tours of inspection throughout the district; delivered 365 tons of coal and 2 cords of wood; recovered one whistling buoy from the beach and one found drifting out at sea. This tender performed the special service of breaking the blockade of ice at several stations, and relieving the keepers with provisions and water; and was also engaged in marking with buoys the route of the naval parade. In the discharge of her various duties, she steamed 8,150 miles and consumed 467 tons of coal. She is kept neat and serviceable. During the year the *Gardenia* was furnished with engineer's stores, a new boiler, tableware, fire brick, paints, medicines, ship chandlery, hose, provisions, and fuel.

The Mistletoe.—This steamer was almost continuously engaged on works of repair. She is in fair condition as to her hull, but her boiler and engine need renewal. Such repairs were made as to make them safe to use. During the year she ran about 7,570 miles with a consumption of some 782 tons of coal.

The Rose.—The new boiler and engine put in this steamer, after she was lengthened 15 feet, have not yet given satisfaction. As a consequence she has been of but little use during the year.*

Launch Nettle.—Minor repairs were made to this launch. She was usefully employed in Lake Champlain, the Hudson River, and in carrying workmen and light freight about New York Bay and Harbor. During the year she ran about 2,995 miles, with a consumption of some 53 tons of coal.

TENDER FOR ENGINEER OF THE THIRD LIGHT-HOUSE DISTRICT.

The engineer's tender, the *Mistletoe*, is the oldest tender in this district, and one of the oldest in the service. She was built in 1871–'72. She has done good service, but to put her in effective condition would require new boilers, engine, shafting, wheels, and such other radical changes, that it would be more economical to build a new boat of a stronger and more modern type.

The following recommendation, made in the Board's last annual report, is renewed:

A new steel screw steamer is needed to take the place of an old side-wheel steamer. The latter has been nearly worn out by long and hard service in the waters of Long Island Sound and on the seacoast of New York. She is too small to do the work of

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*The boiler and engine are now in proper order and the tender is doing good work.

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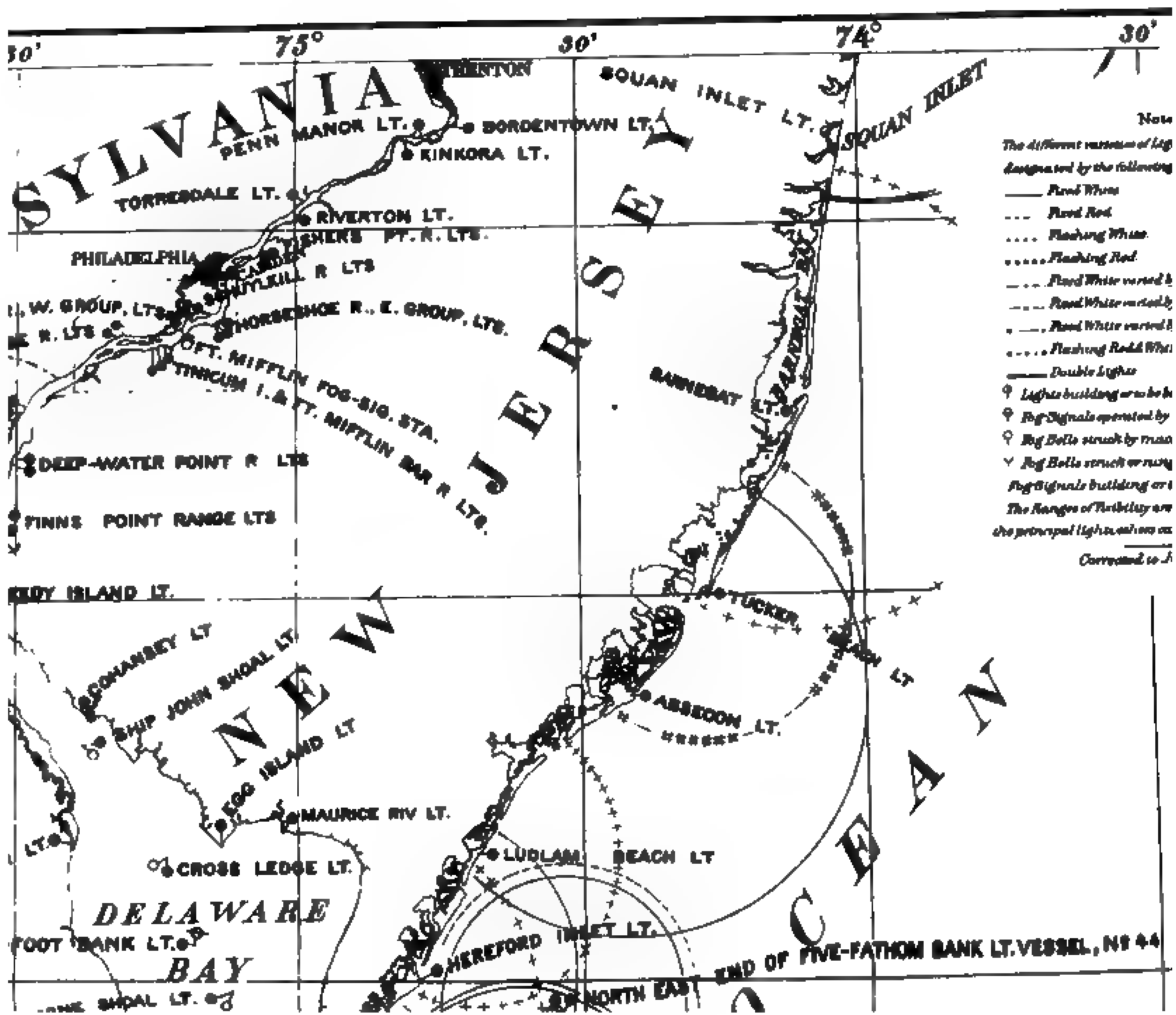
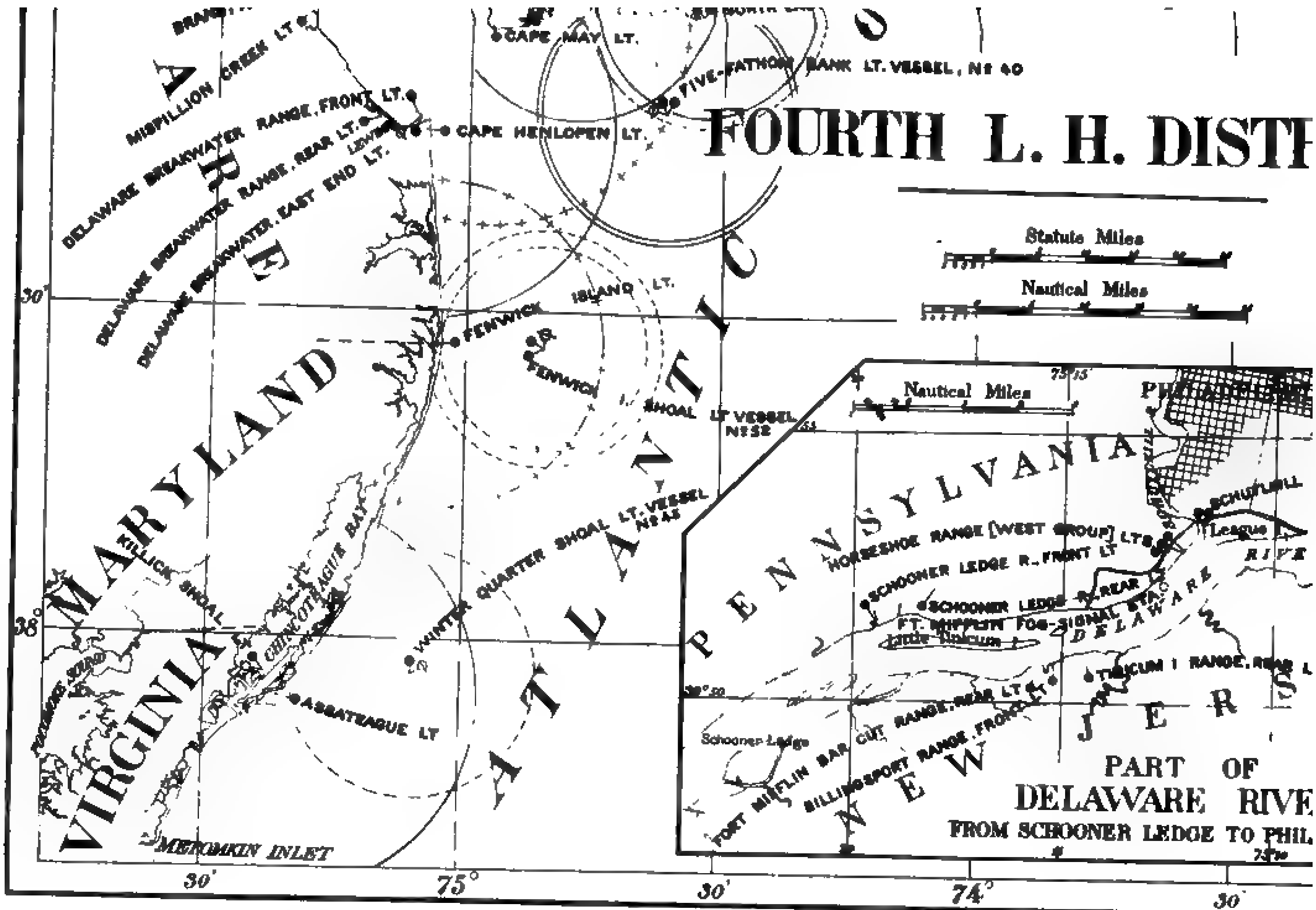
the third light-house district properly. She is so slow that a great deal of time is lost unnecessarily. The needs of this district, which is the largest and most important of the country, would be far better and more economically subserved by a steamer of the latest design. It is estimated that such a steamer can be built, fitted out, and made ready for service at a cost not exceeding $95,000, and it is recommended that an appropriation of this amount be made therefor.

It will cost between $35,000 and $40,000 to put the *Mistletoe* in good order. Should such an expenditure be made, she will be still ill adapted to the work she has to do, because she is a side-wheel vessel, and because she will never have the necessary speed.



75°
30'
74°
30'
SYLVANIA
PENN MANOR LT.
BORDENTOWN LT.
KINKORA LT.
SQUAN INLET LT.
SQUAN INLET
TORRESDALE LT.
RIVERTON LT.
PHILADELPHIA
SCHUYLKILL R LTS
HORSESHOE R., E. GROUP, LTS.
FT. MIFFLIN FOG-SIG. STA.
TINICUM I. & FT. MIFFLIN BAR R LTS.
DEEP-WATER POINT R LTS
FINNS POINT RANGE LTS
NEW JERSEY
BARNEGAT LT.
TUCKER
ABSECON LT.
COHANSEY LT
SHIP JOHN SHOAL LT.
EGG ISLAND LT
MAURICE RIV LT.
CROSS LEDGE LT.
LUDLAM BEACH LT
HEREFORD INLET LT.
DELAWARE BAY
OCEAN
END OF FIVE-FATHOM BANK LT.VESSEL, Nº 44
NORTH EAST
Note
Fixed White
Fixed Red
Flashing White
Flashing Red
Double Lights


FOURTH L. H. DIST
Statute Miles
Nautical Miles
CAPE MAY LT.
FIVE-FATHOM BANK LT. VESSEL, No 40
MISPILLION CREEK LT.
DELAWARE BREAKWATER RANGE, FRONT LT.
DELAWARE BREAKWATER RANGE, REAR LT.
DELAWARE BREAKWATER, EAST END LT.
CAPE HENLOPEN LT.
FENWICK
ISLAND LT.
FENWICK
SHOAL LT VESSEL No 52
WINTER QUARTER SHOAL LT. VESSEL
KILLICK SHOAL
CHINCOTEAGUE BAY
ASSATEAGUE LT
MEROMKIN INLET
MARYLAND
VIRGINIA
ATLANTIC
30'
75°
74°
38°
Nautical Miles
PENNSYLVANIA
SCHUYLKILL
League
HORSESHOE RANGE [WEST GROUP] LTS.
SCHOONER LEDGE R., FRONT LT
SCHOONER LEDGE R., REAR
FT. MIFFLIN FOG-SIGNAL STA.
Little Tinicum
DELAWARE
TINICUM RANGE, REAR L
FORT MIFFLIN BAR CUT RANGE, REAR LT
BILLINGSPORT RANGE, FRONT LT
Schooner Ledge
NEW JERSEY
PART OF
DELAWARE RIVE
FROM SCHOONER LEDGE TO PHIL

FOURTH DISTRICT.

The fourth district extends from Shrewsbury River, New Jersey, to and including Metomkin Inlet, Virginia, and embraces all the aids to navigation on the seacoast of New Jersey below the Highlands of Navesink, on the Delaware Bay, the Delaware and Schuylkill rivers, the seacoasts of Delaware and Maryland, and part of the seacoast of Virginia.

Inspector.—Commander Purnell F. Harrington, U. S. Navy.

Engineer.—Capt. Edward Maguire, Corps of Engineers, U. S. Army, to October 11, 1892; since then, Capt. Frederick A. Mahan, Corps of Engineers, U. S. Army.

In this district there are:

Light-houses and beacon lights, including 7 post lights	56
Light-ships in position	4
Day or unlighted beacons	4
Fog signals operated by steam or hot-air engines	6
Fog signals operated by clock work	7
Whistling buoys in position	4
Bell buoys in position	6
Ice buoys for winter use	13
Other buoys in position	175
Steamer *Zizania*, buoy tender and for supply and inspection	1
Schooner *Clover*, for construction and repairs	1

LIGHT-STATIONS.

358. *Squan Inlet, seacoast of New Jersey.*—A new site was selected and measures were taken for its purchase and obtaining title.

359. *Barnegat, Barnegat Inlet, seacoast of New Jersey.*—Alterations to the dwelling, to give suitable and sufficient accommodation for the keepers, were begun in April. The interior of the present dwelling was entirely remodeled and refitted, as was a portion of its exterior. An addition was made to the house of the second assistant keeper, as the present dwelling admitted of but two rooms for the use of himself and family. The work is now well advanced. Repairs were made to the roof of the tower, which leaked badly.

NOTE.—The keepers moved into the new dwelling on September 14, 1893.

361. *Absecon, Absecon Inlet, seacoast of New Jersey.*—The additions and alterations to the assistant keeper's dwelling, in progress at the close of the last fiscal year, were completed. Slight alterations were also made to the interior of the principal keeper's dwelling and its chimney was rebuilt. A new main for water supply was laid, with

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connections for carrying the water into the dwelling. The waste and rain pipes were also connected with the sewage mains of Atlantic City. The walks were partly relaid, repairs were made to the outbuildings, and the call-bell system was overhauled and rearranged. A brick oil house was built.

366. Cape May, north side of entrance to Delaware Bay, seacoast of New Jersey.—A brick oil house, 14 feet by 18 feet in plan, was built, and various minor repairs were made.

369. Delaware Breakwater front range, Delaware.—The characteristic of this light was changed on September 15, 1892, from fixed white varied by a white flash every 45 seconds, to fixed white during periods of 2½ seconds, separated by eclipses of 2½ seconds' duration.

—. Big Oyster Beds, mouth of Maurice River, Delaware Bay, New Jersey.—The establishment of a light and fog signal here, at a cost not exceeding $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

371. Mispillion Creek, Delaware Bay, Delaware.—A narrow red sector was placed in this light, to mark the line of turning into Mispillion Creek.

376. Cross Ledge, Delaware Bay, Delaware.—The foundation pier was seriously damaged by ice during the past winter. Measures are being taken for its repair.

—. Salem Creek light-station, southern side of Salem Creek, Delaware Bay, New Jersey.—The establishment of a light-station here, at a cost not exceeding $800, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

383. Reedy Island, Delaware River, Delaware.—The characteristic of this light was changed November 30, 1892, from a flashing light to a fixed light of the fifth order. This change is temporary, provision having been made by Congress to make this light the front one of a range. The rear light-house of the range is to be placed in or near the town of Port Penn, Del. The color of the dwelling at this station was changed from drab to white, with lead-color trimmings and green shutters.

390. Christiana Beacon, mouth of Christiana River, Delaware.—Owing to settlement and other causes, the pier, at the outer end of the jetty on which the beacon now stands, has become unsafe and renders a new foundation for it necessary. This was begun and is now under construction. Slight repairs, made necessary by a sailing vessel fouling with the beacon, were made.

398. Fort Mifflin Bar Cut Range (rear), below Billingsport, Delaware River, New Jersey.—The station was put in thorough order, and minor repairs were made.

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418. Assateague, Assateague Island, seacoast of Virginia.—The interior of the keeper's dwelling was torn out and it was remodeled and refitted, and additions to it were made to give the keepers proper and necessary living rooms.

REPAIRS.

At each of the following-named stations, repairs of greater or less extent, were made during the year:

360 Tucker Beach, N. J.
368. Delaware Breakwater (East end), Del.
369. Delaware Breakwater Range (front), Del.
370. Delaware Breakwater Range (rear), Del.
371. Mispillion Creek, Del.
372. Brandywine Shoal, Del.
374. Maurice River, N. J.
375. Egg Island, N. J.
379. Cohansey, N. J.
381, 382. Port Penn Range, Del.
384. Finns Point Range (front), N. J.
387. New Castle Range (rear), Del.
388, 389. Deep-Water Point Range, N. J.
391. Christiana, Del.
392, 393. Cherry Island Range, Del.
394, 395. Schooner Ledge Range, Pa.
396. Billingsport Range (front), N. J.
397. Tinicum Island Range (rear), N. J.
400, 401, 402. Horseshoe Range, West Group, Pa.
403, 404, 405. Horseshoe Range, East Group, N. J.
416. Fenwick Island, Del.
419. Killick Shoal, Va.

LIGHT-SHIPS.

364. Northeast End of Five-Fathom Bank light-vessel, No. 44, off the seacoast of New Jersey.—On May 3, 1893, this vessel was relieved by light-ship No. 37 and brought in for docking and repairs. She was taken on the dry dock and the bottom thoroughly cleaned and painted with two coats of germicide paint. An examination, while in dock, showed that the plates of the bottom were slightly pitted, except in places where it was still covered by red lead, put on in November, 1889. The germicide paint, which was put on in February, 1891, had disappeared. It is recommended that the vessel be docked again in the spring of 1894, for examination and for the renewal of the anticorrosive paint. Repairs were made to the steering gear, windlass, ventilators, hoisting winches, boat, boilers, etc. A new set of tubes for each boiler was furnished. Twenty-five tons of coal for use of the steam fog signal were put on board when the vessel returned to her station, relieving light-ship No. 37 on June 13, 1893. Seventy-five tons of coal, for the use of the vessel and fog signal, were supplied during the year. Rations, paint, galley, caboose, medicine, etc., were also supplied.

365. Five-Fathom Bank light-vessel, No. 40, off the seacoast of New Jersey.—The vessel is in need of repairs to her hull, boiler, etc., and it is proposed to remove her from the station in July. Forty-four tons of coal for the use of the vessel, and fog signal, together with rations, binnacle lamp, rope, spyglass, etc., were supplied.

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NOTE.—Relief light-ship No. 37 was placed on this station in midsummer to replace light-ship No. 40, while under repair. During the cyclone of August 23 and 24, 1893, light-ship No. 37 foundered, and four out of the six men on board were lost. Light-ship No. 40 was not in a condition to resume her station, so the steamer *International*, which could show electric lights, was chartered and placed there within 36 hours from the foundering of the light-ship. The Secretary of the Treasury, in his letter of September 8, 1893, to the Speaker of the House of Representatives and the President of the Senate, asked an appropriation of $70,000 to build another light-ship to replace the one lost.

The Light-House Board appointed the inspectors of the fourth, fifth and sixth light-house districts a board to ascertain and report the cause of the wreck of the Five-Fathom Bank light-ship, No. 37. These officers met on October 9, 1893, and examined the two survivors, one an officer, and the other a seaman, and reported the facts found and the conclusion reached.

It appears from the evidence of the assistant engineer that, on the morning of August 23, 1893, the sea was very heavy and was breaking on Five-Fathom Bank. The wind commenced to blow about 5 p. m., and kept increasing until about midnight, when it blew the hardest. A sea boarded the ship about 10 p. m., and others boarded her from time to time every little while. At midnight two boats were lost, and at 1 a. m., the last one was carried away. Every time a sea boarded the ship it was noticed, after she had freed herself, that she had a list to port. As soon as she would free herself from one sea, another would board her. About 1:45 a. m., a tremendous sea boarded her, when she went over on her beam ends and went down sideways to port. The assistant engineer went down with the ship and, when he came to the surface, caught the main hatch scuttle and was supported by it until he was picked up about 6 p. m., some sixteen hours after, by a pilot boat. The ship was lying to about 50 fathoms of chain cable, and there was no effort made to veer chain. There were seven openings in the spar deck. All were so covered as to keep out the seas in the early part of the storm, but it appears that the coverings of the larger and more important ones fetched loose at the height of the storm and left the vessel quite open. The most important opening was the main hatch. It was covered with a scuttle which measured about 4 feet by 5 feet. This scuttle was not even lashed down until about 9 p. m., on August 23. About 11 p. m. it was washed loose, when it was at once relashed; but it was eventually carried away, and it was on this hatch that the assistant engineer was saved.

The barometer stood at 29 inches, even, at 1:30 a. m., 15 minutes before she foundered. One witness, the seaman, stated in effect that, about 1:30 a. m., August 24, there seemed to be a lull in the wind. The ship then came broadside to, and each sea struck her on the side

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and threw her down on her beam ends. When the ship went over, all hands were thrown into the water and went under. The seaman stated that when he came up he got hold of the hatch scuttle, but, finding three men on it, he let go and, after trying several pieces of wreck, each of which were too small to carry him, he got hold of a part of a lamp house, to which he clung until daylight, when he got hold of a gaff besides. He got astride of this gaff and put the piece of the lamp house across it and clung to that until he was picked up by a pilot boat about 7 p. m., having been in the water some seventeen hours.

It appears that the hatches were secured by its rings lashed to rings in the coaming. The main hatch scuttle was put on about 8 p. m. but it was not then lashed. At 9 p. m. it was lashed with lanyards of ratline stuff. After this, the hatch was washed off by the sea, some of the ringbolts being broken by the force of the sea. It was then lashed with a piece of rope across the top from side to side, to ringbolts in the deck. It does not appear that any effort was made to batten down the hatches by the use of tarpaulins nailed to the deck. It does not appear that other than ordinary efforts were made to secure this hatch, although the circumstances were most unusual.

One witness states that the ship had a list to port of about one-half plank on account of the large boat on the port side, and the weight of the chain of the second anchor, and that this list was increased about a plank and a half more. This same witness stated that when the last three or four seas boarded the ship, she failed to free herself of water between the seas. The cause of this, he thought, was that the chain of the two anchors which was ranged on deck went down to leeward, increasing the list so that at times the lee freeing ports were closed by the pressure of the sea outside. His theory as to the loss of the vessel was that she swung broadside to the sea which turned her over. The sea struck her under the bilge, she having at that time much list. She sank, he thought, by reason of *the water getting in through the hatch that was washed off; through the companion-way which was open and perhaps other hatches were washed off.* In speaking of the character of the seas he said that they were regular heavy rollers like breakers on the beach. It seemed to him as if they came from the bottom. There "would be small ones and then awful big ones." "There were four big ones in succession, and the fourth turned the ship over."

The board of officers who took this evidence brought in a verdict that the vessel was thrown on her beam ends by a succession of enormous seas striking her directly on the bilge without sufficient intervals between them to permit her to free herself; that when she was on her beam ends water was free to get in through the forward ventilator, the main hatch, and the companion way, and that this was sufficient to account for her foundering. It was further found that the chain was

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not veered to its full scope, as is required by the regulations of the Light-House Board. The board of officers fixed the responsibility for failure to veer chain on the assistant keeper in charge, who was lost when the vessel foundered.

This is the first instance in the history of the United States Light-House Establishment in which a light-ship has foundered at her moorings. The Light-House Board is of opinion that if the assistant keeper in charge of the ship during this terrible storm had been a man of larger experience and more resources that he would have found means to batten down the hatches, and especially the main hatch, so that the water would have been kept out of the ship. Comparisons are invidious and often unjust; but the Board believes that the result would have been different if the same intelligence and ability that was shown on Rattlesnake Shoal light-ship when she was stranded on August 27th had been shown on Five-Fathom Bank light-ship during this storm of August 23d. The Rattlesnake Shoal light-ship was torn from her moorings and driven on the beach, but her hatches had been so thoroughly battened down that sometime after she had been beached it was found that she had but a few inches of water in her. If the hatches of the Five-Fathom Bank light-ship had been battened down as thoroughly as were those of the Rattlesnake Shoal light-vessel, and if her chain had been veered to the bitter end, as was that of the Rattlesnake Shoal light-vessel, it is believed that she would have ridden out the storm.

415. *Fenwick Island Shoal light-vessel, No. 52, off the seacoast of Maryland.*—This new vessel arrived at Wilmington, Del., September 1, 1892, and was accepted on September 27. The following work was done in preparing her for service, viz: Billboards were fitted for the mushroom anchors, and eyebolts were placed for securing anchors. An ash pan was placed under the donkey boiler. Drain pipes were fitted for carrying rain water from the forecastle deck to the boiler and tanks. The lantern houses were lined with yellow metal. The positions of the anchor davits were changed and the rail was altered for the hoisting winch for the after lantern. Two booms were fitted for hoisting in supplies. Two pop valves were fitted. A new cover for the forward hatch and oil room was fitted. Extra fastenings were put in for the surge relievers. A booby hatch was fitted for the berth deck, as were dish racks, sideboard, and dresser in the galley. Berth drawers and doors were refitted. New lamp boxes were built. The lanterns were glazed. Two sets of grate bars, two pop safety valves, chain for securing anchors, two deck stoppers, 70 tons of coal, ship chandlery, engineer supplies and tools, paint, hose, etc., were supplied. The vessel was placed on her station relieving light-ship No. 37, on December 15, 1892.

—, *Light-Vessel No. 37.*—This vessel was removed from Fenwick Island Shoal station on December 15, 1892, and brought to Edgemoor supply

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depot to be used as a relief vessel. In preparing her for service the following necessary repairs were made: She was hauled out on the railway; the outside was calked from metal line to rail, and the bulwarks inside were also calked; the main and forecastle decks were thoroughly calked and the seams were filled with white lead; a new bowsprit, foremast, and main boom were furnished and fitted; a new eye was put on the clapper of the fog bell, and twelve mast hoops were fitted. The ironwork on the rudderhead was refitted, and a new Monitor galley stove No. 5, with all fixtures, was supplied. Ten tons of coal, one spyglass, one forestay sail, etc., were supplied. On May 3, 1893, she was placed on Northeast End station, relieving light-vessel No. 44, where she remained until June 13, when she was in turn relieved by No. 44, and brought to Edgemoor supply depot to be prepared for service on Five-Fathom Bank station to relieve light-vessel No. 40.

417. *Winter-Quarter Shoal light-vessel, No. 45, off the seacoast of Virginia.*—This vessel has remained on her station the entire year and is in good condition. Rations, wood, coal, a foresail, lumber, boiler tubes, medicine, rope, valve springs for the pump, etc., were supplied. In September, 1892, 120 fathoms of 2-inch chain, bearing the stamp "U. S.," were taken from the vessel and 120 fathoms of 2-inch chain of different make substituted.

DAY OR UNLIGHTED BEACONS.

Deadman Shoal day beacon.—This beacon was carried away during the past winter, it is supposed, by the heavy ice.

The other day-marks have received no repairs, being in good condition.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

364. *Northeast End of Five-Fathom Bank light vessel, No. 44, New Jersey.*—The 12-inch steam whistle was in operation 609½ hours between July 1, 1892, and May 3, 1893, and from June 13 to 30, 1893, and consumed about 33 tons of coal.

365. *Five-Fathom Bank light-vessel, No. 40, New Jersey.*—The 12-inch steam whistle was in operation 451 hours, and consumed about 22 tons of coal.

368. *Delaware Breakwater, East End, Delaware.*—This second-class Daboll trumpet was in operation 673 hours, and consumed about 4 tons of coal.

373. *Fourteen-Foot Bank, Delaware Bay, Delaware.*—This second-class Daboll trumpet was in operation about 254 hours, and consumed some 2 tons of coal.

415. *Fenwick Island Shoal light-vessel, No. 52, Maryland.*—This 12-inch steam whistle was in operation about 283 hours from December 15, 1892, to June 30, 1893, inclusive, and consumed some 28 tons of coal.

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Winter-Quarter Shoal light-vessel, No. 45, Virginia.—This 12-inch histle was in operation some 391 hours and consumed about 19 coal.

BUOYAGE.

were maintained last year on the seacoast from Squan Inlet, rsey, to Chincoteague Inlet, Virginia, 27 buoys; in Barnegat buoys; in Tucker Cove and Little Egg Harbor Inlet, 13 buoys; con Inlet, 4 buoys; in Great Egg Harbor Inlet and River, 13 in Hereford Inlet, 5 buoys; in Delaware Bay and River and ill River, 109 buoys; in Chincoteague Inlet, 5 buoys, and in in Inlet, 3 buoys; a total of 188 buoys.

uoyage of Delaware River and Bay, of the seacoast of the dis- d of Chincoteague Inlet was kept in order by the light-house ender *Zizania*. The buoyage of Barnegat, Tucker Cove, Little arbor, Absecon, Great Egg Harbor (except the outer or sea first-class can), and Hereford Inlets, on the New Jersey coast, ll attended to by contract, as was that of Metomkin Inlet.

ron ice buoys were in position in the Delaware Bay and River, re entire satisfaction, 61 being in use during the winter.

BUOYS PLACED DURING THE YEAR.

first class cans painted yellow, with the letter Q on two sides in near the Shears Shoal, Delaware Bay, to mark the National tine anchorage ground.

hird-class nun, black and white perpendicular stripes, between and 7, in Barnegat Inlet Harbor.

whistling buoy, red, to mark the wreck of schooner *Annie S.*

ell buoy, red, to mark the wreck of schooner *Annie S Gaskill.*

econd-class iron ice buoy to mark the end of dike, at present ged, off Finns Point, New Jersey.

par, red and black horizontal stripes, to mark the wreck of canal boat off Bridesburg Wharf, Delaware River.

BUOYS DISCONTINUED AS NO LONGER NECESSARY.

hird class nun, red, from abreast of an old steamship's boiler egat Inlet.

third class can, black and white perpendicular stripes, third ittle Egg Harbor Inlet.

ell buoy, black, marking the wreck of the steamer *Florida.*

irst class can, yellow, quarantine buoy, near Shears Shoal, Del- ay.

whistling buoy, red, marking wreck of schooner *Annie S. Gaskill.*

Fourth District.

One bell buoy, red, marking wreck of schooner *Annie S. Gaskill.*

One first-class can, red and black horizontal stripes, marking the wreck of the barge *McClellan.*

One second-class iron ice buoy, red and black horizontal stripes, marking the wreck of the steam barge *A. J. Miller*, Delaware Bay.

DEPOTS.

Edgemoor supply and buoy depot.—The outside of the storehouse was yellow washed and the roof painted red.

The present timber wharves were built only a few years ago. They are now in exceedingly bad condition and unsafe for the service of the district. Experience having shown that timber, even when creosoted, is ill adapted for use at this place, the wharves should be built of masonry and iron.

The basin was dredged out not more than two years ago. Since then it has become silted up to such an extent as to make it impossible for vessels to lie therein. It will cost about $20,000 to dredge the basin to a proper depth.

As a whole the condition of the depot could not be much worse than it is.

Chincoteague Inlet, Virginia.—The spare buoys for Chincoteague and Metomkin Inlets, Winter-Quarter Shoal and Ship Shoal are stored here. It is also used as a depot for Assateague and Killick Shoal light-houses and for the care of boats from Winter-Quarter Shoal light-vessel. The depot occupies half of a small wharf, and the frontage is inadequate to properly accommodate and secure the tender while lying there, and the buoy house is not adapted to the care of the light-vessel's boats.

Absecon, Absecon Inlet, New Jersey.—The following recommendation made in the Board's last two annual reports is renewed: An appropriation of $1,500 was made by the act approved on October 2, 1888, for the purchase of a site and the erection of a buoy depot at this place. It has been found that, after paying for the site and for the legal services incident to its purchase, the balance of the appropriation remaining is insufficient for the construction of a depot building. It is estimated that this work can be done for $2,000, and an appropriation of that amount is recommended for this purpose.

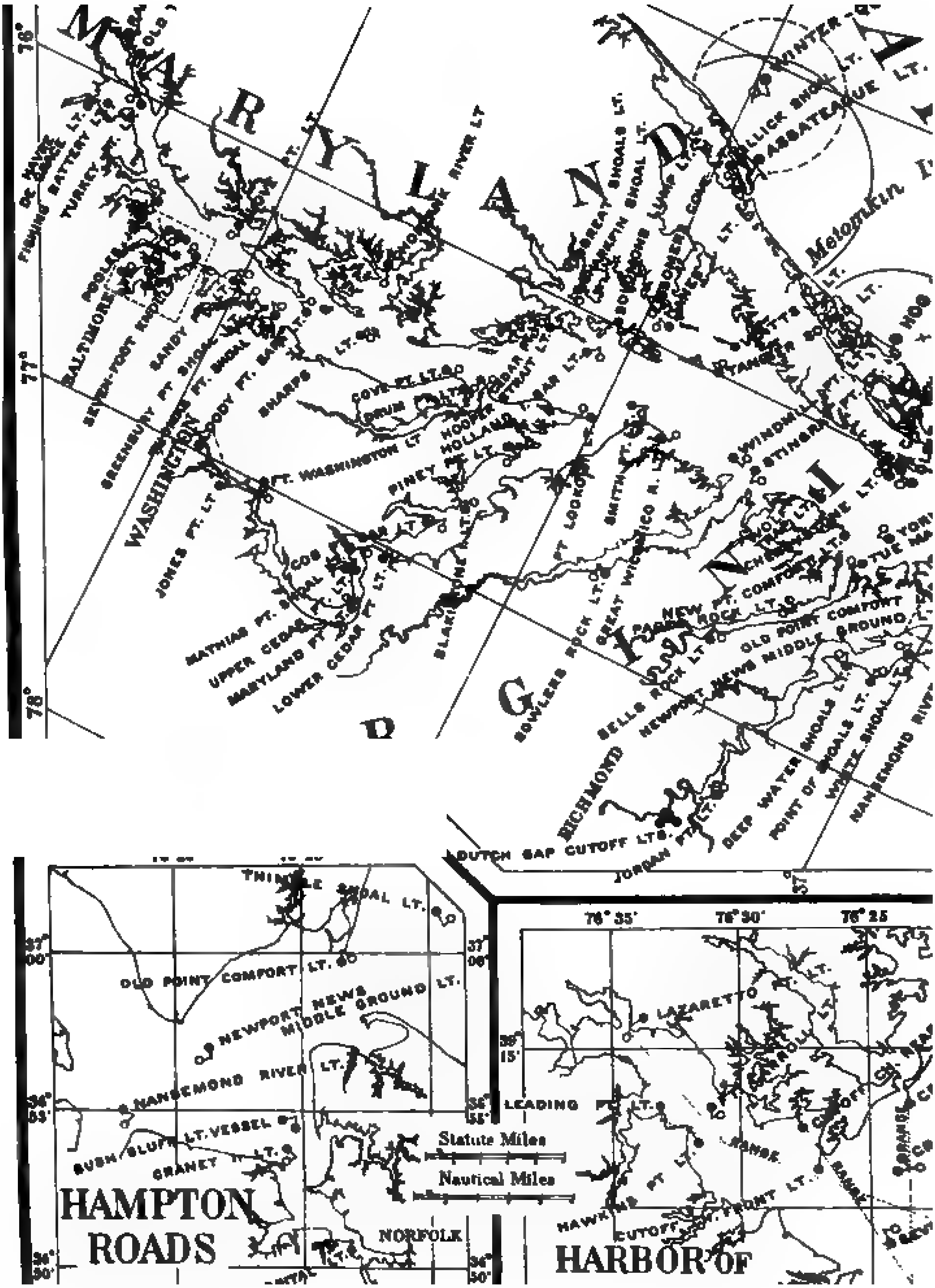
Cape May, New Jersey.—The following recommendation made in the Board's last two annual reports is renewed: An appropriation of $750 was made by the act approved on October 2, 1888, for the purchase of a site and the erection of a boathouse for light-ships' boats at this place. The purchase of the site for a boathouse has been completed, and it is found that the balance of the appropriation is insufficient for the erection of a suitable structure. It is estimated that this work can be done for $800, and recommendation is made that an appropriation of this amount be made for that purpose.

Fourth District.

TENDERS.

The Zizania.—This steamer was on duty throughout the year, except twenty-five days during which she was laid up for repairs. On May 27, 1893, she was taken out on a railway and the bottom thoroughly cleaned and painted with two coats of germicide paint. A careful inspection of her bottom before and after cleaning showed that there was little remaining of the germicide paint which was put on in May, 1892. The bottom shows no deterioration and is in good condition. The stern posts and the plates about them have suffered no deterioration since iron propellers were substituted for the composition ones in March, 1891. The tender was engaged on the buoyage of the district, in towing light-vessels to and from stations, in towing the schooner *Drift* to the Portsmouth buoy and supply depot, Va., and in delivering fuel and supplies to light-houses. One trip was made to the general depot at Tompkinsville, N. Y., for supplies and buoys. She replaced 48 buoys, changed 194, painted 3, placed 8, shifted 8, and removed 6. She landed 109 tons of coal and 9½ cords of wood at 19 light-stations and 253 tons of coal and 2½ cords of wood at 5 light-vessels. The crew was employed 103 days at Edgemoor supply and buoy depot. She delivered the annual allowance of provisions to 4 light-vessels and 11 light-stations. She also conveyed the inspector to the light-stations of the district for the purpose of inspection, and she delivered the necessary supplies to the stations. In doing all this she steamed 11,677 miles and consumed about 773½ tons of coal and 5 cords of wood. Necessary supplies, such as rope, oil, waste, soda, paint, baskets for coaling stations, packing, etc., were furnished. The following repairs to her hull were made: The iron sheathing and wood filling of two buoy gangways were taken off, the hull was cleaned and painted, new wood filling was put in and iron sheathing replaced, the rail of the port buoy gangway was repaired and a new brass casting was put on; four deadlights were put in the main deck, forward; new wearing plank of the side fenders was fitted and the chafing iron was replaced; the doors and sash of the pilot house were refitted; storm panes of galvanized iron were fitted to the gangway doors, the forward rail in wake of the sinker stoppers was renewed. The repairs to the engine were a cast-iron collar for the thrust bearing, new pins for the air-pump connections, valves in the feed pumps, 3 feet of 4-inch copper feed pipe renewed, and two new bonnets furnished for the check valves. On April 13, 1893, a contract was made to remove the old boiler and to furnish and put in, ready for service, a steel boiler with all the necessary appurtenances, including a fresh-water tank.

The Clover.—The sailing tender *Clover* was thoroughly repaired.



WASHINGTON
RICHMOND
DUTCH GAP CUTOFF LTS.
THIMBLE SHOAL LT.
OLD POINT COMFORT LT.
NEWPORT NEWS MIDDLE GROUND LT.
NANSEMOND RIVER LT.
BUSH BLUFF LT. VESSEL
Statute Miles
Nautical Miles
HAMPTON ROADS
NORFOLK
LEADING
LAZARETTO PT. LT.
HARBOR OF

Fog Bells struck by machinery.
Fog Bells struck or rung by hand.
Fog Signals building or to be built are dotted.
The Ranges of Visibility are indicated only for some of the principal lights, others can be found in the L.H. List.
Corrected to June 30, 1893.
ATLANTIC OCEAN
NORTH CAROLINA
CAPE CHARLES LT.
CAPE CHARLES LT. VESSEL, No 46
CAPE HENRY LT.
CURRITUCK BEACH LT.
BODIE ISLAND LT.
CAPE HATTERAS LT.
OUTER DIAMOND SHOALS LT.
HATTERAS INLET LT.
HATTERAS BEACON
OCRACOKE LT.
ROYAL SHOAL LT.
HARBOR I. BAR LT.
CAPE LOOKOUT LT.
NORTH RIVER LT.
CROATAN LT.
LAUREL PT. LT.
WADE PT. LT.
CURRITUCK SOUND LTS.
NORTH LANDING RIVER LTS.
ROANOKE RIVER LT.
EDENTON HBR RANGE
MC WILLIAMS PT. SHOAL LT.
PAMLICO
NEUSE R.
Statute Miles
Nautical Miles
10 5 0 10 20 30 40 50
74°
75°
76°
77°
78°
36° 10'
River Inlet

FIFTH DISTRICT.

The fifth district extends from Metomkin Inlet, Virginia, to include New River Inlet, North Carolina, and embraces part of the seacoasts of Virginia and North Carolina, all of Chesapeake Bay, the sounds of North Carolina, and the rivers tributary thereto.

Inspector.—Commander Charles J. Train, U. S. Navy, to December 31, 1892; Commander Yates Stirling, U. S. Navy, from December 31, 1892.

Engineer.—Capt. Eric Bergland, Corps of Engineers, U. S. Army.

In this district there are:

Light-houses and beacon lights, including 2 post lights	110
Light-ships in position, including tender *Holly*	3
Day or unlighted beacons	14
Fog signals operated by steam or hot-air engines	4
Fog signals operated by clockwork	66
Whistling buoy in position	1
Bell buoys in position	2
Other buoys in position, including pile buoys and stakes	1,149
Steamers *Maple*, *Holly* and *Violet*, buoy tenders, and for supply and inspection	3
Steam launch *Bramble*, used to supply gas to the beacons in the sounds of North Carolina	1
Sharpie (and gas tank) for supplying beacons and coast stations	1
Steamers *Jessamine* and *Thistle*, for construction and repairs	2

LIGHT-HOUSES.

420. Hog Island, Great Machipongo Inlet, seacoast of Virginia.—Some difficulty and much delay were experienced in acquiring title to the land needed for building a wharf and roadway at Hog Island. The United States Attorney, charged with this duty, reported at first that the title was defective, but subsequently reconsidered his opinion and prepared a deed of conveyance.

On account of absence of the owner and for other reasons, this deed was not executed until January, 1893, and the title had not been finally passed upon by the United States Attorney up to the date of his resignation in April. His successor is now engaged upon a review of the papers, and it is expected that a decision will soon be had. Meanwhile plans for the proposed wharf have been prepared, so that there may be no unnecessary delay after the site shall have been secured. The plans for a structure of the same class as that at Cape Charles, Va., to be built of iron, had already been completed. Arrangements were promptly made for the incorporation therewith of the Hog Island structure, and in April, 1893, bids were asked for building both light-towers. The

Fifth District.

bids were opened on May 17, and the lowest bid, that of $78,200, for both light-houses, was duly accepted. Contracts were made with the lowest bidder, and the construction of the ironwork was commenced. Negotiations are progressing for the acquisition of a new site for the Hog Island light-station. The owner of the needed land offers to exchange it for the present light-house tract, although it is inferior in value. It is recommended that Congress be asked to grant the necessary legislation to authorize the exchange, as the Government will be benefited thereby. By act approved March 3, 1893, Congress appropriated $30,000 for replacing by a first-order light, the fourth-order light now at Hog Island, and authorized contract therefor to the amount of $125,000. The Board now recommends that appropriation be made for the balance of the $125,000, that is for $95,000, that Hog Island light-house may be duly completed.

422. Cape Charles, on Smith Island, entrance to Chesapeake Bay, seacoast of Virginia.—Title was secured in 1892, by condemnation, to a tract of 10 acres of land required for the site of the new light-station. The plans and specifications for the proposed tower were completed in April, and bids were received in May for furnishing and erecting at the respective sites, this and the new tower for use at Hog Island, Virginia. Designs were completed for the new dwellings and outhouses and for the temporary wharf and tramway for landing and transporting materials.

425. Old Point Comfort, entrance to Hampton Roads, Virginia.—In June 50 cart loads of earth were deposited around the front of the dwelling to grade the premises, and about 300 running feet of galvanized-iron pipe were laid to connect the station with the water supply at Fort Monroe.

—. Lambert Point, Elizabeth River, Virginia.—This light was of little or no value because of its obstruction by the coal piers of the Norfolk and Western Railroad, and of its being overpowered by the electric lights. The light was discontinued, therefore, on December 31, 1892. The illuminating apparatus, the fog-bell machinery, and the outfit of supplies and implements were removed from the station and were stored at the Lazaretto depot for safe keeping.

—. Doller Point and Hog Island Wharf, James River, Virginia.—The following recommendations, made in the Board's annual reports for the last three years, are renewed:

> Lights have been maintained at these points for several years by private enterprise, and their value to the public interests of navigation is now evident. It is therefore recommended that proper measures be taken for establishing range lights at Dollers Point, to guide vessels through the narrow and shallow channels known as Goose Hill Slough, between Hog Island and Jamestown Island; also for the establishment of an inexpensive light on the wharf at Hog Island, to lead the way through another difficult channel from Deep-Water Shoals light to the north point of Hog Island, where an abrupt turn is made to enter Goose Hill Slough. The estimated

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cost of these lights is $2,500, and it is recommended that this amount be appropriated therefor.

434. Jordan Point, James River, Virginia.—In June the protection of the light-house site, proposed in the Board's last annual report, was undertaken and completed. It consists of sheet piling, 3 inches by 12 inches by 10 feet, backed by oak and pine piles driven firmly in the ground and connected by 6-inch by 12-inch cap logs and 4-inch by 8-inch stringpieces, to which the sheet piles are secured. The shore protection is 279 feet long on the channel or eastern side of the point, and 133 feet on the western. The old fence on the east side was taken down at the same time and rebuilt on a line with the shore protection. Minor repairs were made.

439. Old Plantation Flats, Chesapeake Bay, Virginia.—In January the shock of the moving ice overturned and broke the lens. The light was discontinued, but only temporarily. A spare fifth-order lens was substituted in February, which was as soon as the tender could get to the station. No damage to the structure was done by the ice. Various repairs were made.

446. Pages Rock, York River, Virginia.—The metalwork of this light-house was delivered by the contractors in November, too late in the season to undertake the erection of the house. Little was done toward the completion of the superstructure before June. It is expected that the latter will be completed early in July, and that work at the site will be commenced before August 1.

449. Wolf Trap, on a shoal between York and Rappahannock Rivers, Virginia.—This light-house was carried away by the ice on January 22, 1893. The illuminating apparatus and most of the other portable property were recovered from the floating wreck, carried to Portsmouth depot, Va., and stored there.

Measures were at once taken to obtain funds for rebuilding this important station. Congress at its last session appropriated $70,000 for this purpose. Work was begun at once and the labor will be carried forward rapidly. In compliance with urgent requests from mariners for a light on Wolf Trap Shoal, a gas-lighted buoy was placed temporarily off the former site of the light-house in March. This was replaced on June 30, 1893, by the light-house tender *Holly*, which was moored in the same place and will be made to serve, for the time being, as a light-vessel.

—. Beacon lights on Rappahannock River, Virginia.—The trade on this river is growing rapidly. At certain seasons of the year, ten or more large steamers make weekly trips here, carrying vegetables, fruits and the like. As the river is inadequately lighted, these steamers with their perishable freight often have to tie up at night for the lack of guiding lights. The Board recommends the establishment of a red light, to be shown from an iron beacon placed at the entrance to Carters Creek, at a cost not exceeding $3,000, and of three beacon lights

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to be shown from poles placed on or near Sharp's Wharf, below Suggett Point, on Tappahannock Wharf, and on Taylor's Wharf, at an estimated cost of $100 each. Recommendation is made that $3,300 be appropriated for this purpose.

453. Watts Island, east side of Tangier Sound, Virginia.—In May and June extensive repairs and improvements were made at this station.

455. Janes Island, entrance to Little Annemessex River, Maryland.—In January the fog bell was wrenched from its fastenings by floating ice, toppled over on the boat hoister, which it broke, and then fell into the boat, damaging the latter also. The bell, when recovered, was found to be cracked and unserviceable. It and the boat hoister were replaced by those recovered from the wreck of Solomons Lump light-house. An iron landing ladder was put up in May.

458. Smith Point, mouth of Potomac River, Virginia.—This light-house was much damaged by ice during the winter. The keepers abandoned the station when the danger seemed imminent, and the light was temporarily discontinued. The damage done will be repaired.

461. Blakistone Island, Potomac River, Maryland.—In August and September this station, which was badly in need of repairs, was put in thorough order. The erosion of the water front still continues, and some means of protection will have to be provided in the near future.

462. Cob Point Bar, entrance to Wicomico River, Maryland.—Arrangements are being made to insert a red sector in this light to mark, in conjunction with one in the Lower Cedar Point light, the fifteen and seventeen foot lumps in the Kettle Bottom Shoals.

466. Maryland Point, Potomac River, Maryland.—At the date of the last annual report work on the superstructure was nearly finished. The iron substructure and the lantern were received from the contractors in March, 1892. The millwork was delivered at the Lazaretto depot in July, and by the end of August the framing of the superstructure was completed. It was then taken down and packed for transportation to the site. On October 18, all the materials and the plant for the erection of the light-house having been loaded on scows, the working party left Baltimore on the tender *Jessamine* for the site. This steamer and the tender *Thistle* towed the laden scows. The placing in position of the platform from which the work of setting the substructure could be carried on was commenced on the 20th and finished on the 24th. The shears, hoisting engine, and boiler were put in place on the platform and the metalwork and other materials were transferred to it. The screw piles were then inserted with little difficulty, the sleeve columns and attached disks were secured to the piles, and the connecting braces and the iron base beams for the superstructure were put in place. This work was all done and the erection of the superstructure was begun before the end of October. By December 1 the light-house was finished, and on the 15th its light was exhibited.

Fifth District.

The new structure is hexagonal in plan; it consists of a wooden dwelling resting on seven wrought-iron screw piles 40 feet long, and varying in diameter from 7 inches at the top to 10 inches at the bottom or screw end. The piles penetrate 13 feet into the shoal and are provided with circular disks 5 feet in diameter, which rest on the surface of the shoal and augment the bearing capacity of the screws, the shoal being of such a character as to render this provision advisable. The light is flashing white of the fourth order. A fog bell is struck by machinery during thick or foggy weather a double blow at intervals of 15 seconds.

470. *Solomons Lump, Kedge Straits, Maryland.*—In January the light-house was wrecked by the impact of moving masses of ice. Though not carried from its site, the house was pushed over so that part of it is submerged. All the movable property was taken away and stored. In June a lens-lantern light was established on the wreck to mark its position at night and afford assistance to local navigation. An appropriation of $30,000 was made by the act approved March 3, 1893, for reëstablishing the light-house, and plans are now being prepared for the new structure.

472. *Sharkfin Shoal, between Clay and Bloodsworth Islands, Tangier Sound, Chesapeake Bay, Maryland.*—The light-house was completed early in July, and the light was exhibited August 1, 1892.

—. *Point No Point, west side of Chesapeake Bay, between Potomac and Patuxent Rivers, Maryland.*—The following recommendation, which was made in the last two annual reports, is renewed:

> There is a stretch of about 30 miles between the Cove Point and Smith Point lights which should be better lighted. For a part of the distance navigators are without a guide, where a deviation from their sailing course might carry vessels of heavy draft on to dangerous shoals. There are many of this class of craft now trading to Baltimore, and their number is increasing. A light-house on the shoal off Point No Point would be a useful warning, and a suitable structure can probably be erected there for $35,000. It is recommended that an appropriation of this amount be made therefor.

—. *Cedar Point, mouth of Patuxent River, Chesapeake Bay, Maryland.*—At the last session of Congress an appropriation of $25,000 was made for establishing a light and fog signal on or near Cedar Point. An examination will soon be made to ascertain the best location for the proposed structure and to determine the character of the foundation.

477. *Choptank River, opposite entrance to Choptank and Tred Avon Rivers, Maryland.*—General repairs were made to the woodwork of the superstructure. New boat davits and boat hoisters were furnished and put up. Various minor repairs were made.

—. *Swan Point Bar, east side of Chesapeake Bay, opposite Bodkin*

Fifth District.

Point, Maryland.—The following recommendation made in the Board's annual reports for each of the last five years is renewed:

Swan Point Bar is a very important turning point for vessels navigating the bay. Steamers reach it by long courses, whether approaching it from the north or south. A light on the extreme point of the bar, in about 12 feet of water, would be of great use to vessels navigating the bay, whether bound for Baltimore or for other points. This location is exposed to the large fields of ice which move in the bay. A structure strong enough to resist them it is estimated will cost $50,000.

An appropriation of this amount is recommended therefor.

—. *Baltimore light and fog-signal station, Patapsco River, Chesapeake Bay, Maryland.*—The following recommendation made in the Board's last three annual reports is renewed:

The principal difficulty in the navigation of the Cutoff Channel occurs at its junctions with the Craighill and Brewerton channels. At these places the channel has been widened, and the intention is to still further increase the width. For vessels of small draft there is no difficulty in entering or leaving Baltimore Harbor. It is only in the daytime, when it is difficult to distinguish the buoys which mark the turning points, and for large steamers, that additional aids to navigation are needed. A light-house is most wanted at the mouth of the Cutoff Channel, *i. e.*, where this channel joins the Craighill. On account of the impressible character of the shoal, and the liability to damage or destruction by fields of moving ice, no light-house other than an expensive one, can be made permanent. The estimated cost of a suitable structure is $60,000, and an appropriation of this amount is recommended therefor.

490. Leading Point, Patapsco River, Maryland.—Two new outbuildings, in plan 14 feet by 30 feet and 4 feet by 5 feet, respectively, were built. Various repairs were made.

504. Cape Lookout, seacoast of North Carolina.—A topographical survey of the site was made.

505–514. Beacon Lights in North Landing River, Virginia, and Currituck Sound and North River, North Carolina.—Beacon No. 4, which had been destroyed by the ice, was rebuilt in March and was protected by fourteen fender piles driven around it. Beacon No. 6 was rebuilt at the same time, it having been carried away by ice in January. Some twenty-one fender piles were driven and bolted together in groups as a protection. The superstructure of Beacon No. 7 was rebuilt in March to replace that part of the structure damaged by the ice, and fifteen fender piles were driven and bolted together in bunches. Beacon No. 8, at Long Point, was repaired in March and April. The dwellings of the first and second assistant keepers were repaired somewhat, a room in the boathouse was partitioned off for the gas compressor, and the pressed glass lantern on top of the boathouse was removed and replaced by a lens lantern of the kind in use at the other beacons.

515, 516. North River Bar, entrance to North River, North Carolina.—The range beacons to guide over this bar were erected in March, and on the 23d of the month the lights were exhibited for the first time.

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The front beacon consists of an iron column embracing and resting on a wooden pile and provided with a screw. It supports a disk holding three gas cylinders which in turn uphold the lantern. The focal plane is 19 feet above the water. The rear beacon is composed of three sleeve-columns set upon wooden piles and capped with a triangular iron plate which supports the gas cylinders. Above these rises an iron column upon which the lantern is placed. The focal plane of this structure is 35 feet above the water. The beacons are about three-quarters of a mile apart and show fixed white lights from lens lanterns.

519. *Laurel Point, Albemarle Sound, North Carolina.*—The seven cast-iron columns forming the upper series of the substructure were all broken in greater or less degree by the ice during the winter. There was also a slight lateral movement of the superstructure from its position and a settlement of one of the piles. The light-house has, however, held together with remarkable firmness and there is no danger of a collapse before measures can be taken to straighten and strengthen the structure. This will be done before the coming winter.

—. *Alligator River, at or near Great Shoal, mouth of Alligator River, North Carolina.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

There are no lights on the south side of Albemarle Sound, between Croatan and Laurel Point light-houses, a distance of about 30 miles. Alligator River furnishes the only harbor in this distance. The general and local interests of navigation are of sufficient magnitude to justify the erection of a light-house at this locality. It can be built at an estimated cost of $20,000. Recommendation is made that an appropriation of this amount be made therefor.

—. *Pork Point, on the shoal known as the Blockade, off Pork Point, on Roanoke Island, Croatan Sound, North Carolina.*—The following paragraph from the Board's reports for the last six years is repeated and the recommendation therein renewed:

There are eleven steamers running regularly, together with a large number of sailing vessels passing this point. Much property has been destroyed and many serious accidents have occurred in the vicinity for the want of a light, and the navigation of these waters is dangerous and much dreaded. The obstructions to the westward of the narrow channel, constructed during the war of the rebellion, have never been removed. This is also a turning point for vessels navigating the sound, and steamers, after leaving Croatan and Roanoke Marshes lights for this point can make it by steering a single course only. The Board, therefore, is of opinion that a light-house and fog signal should be established here, and it is recommended that an appropriation of $20,000 be made for the purpose.

524. *Roanoke Marshes, between Pamlico and Croatan Sounds, North Carolina.*—The damage done to the substructure in October by barges, in tow of a tug, swinging against it, and during the winter by floating ice, were repaired by a working party in March and April. Wrought-iron straps, 1½ inches by 3 inches by 2 feet, were placed vertically around the fractures in the cast-iron columns, fastened by tap bolts and encircled by clamp-screw bands, 1½ inches by 3 inches, secured by screw bolts, on each of the five columns. At the same time the tin

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roof of the house was renewed and the lantern deck was recovered with tin. The gallery deck was repaired, and the windows and doors were put in order.

533. McWilliams Point Shoal, Pamlico River, North Carolina.—In April this beacon was badly damaged by a vessel while the light was temporarily extinguished. It was reset in June, a hand lantern having been meanwhile shown from the part of the structure left standing.

—. *Wreck Point, southeast of Cape Lookout, North Carolina.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

The establishment of a small light on this point would be of great assistance to a large number of vessels that seek a lee under Cape Lookout. A suitable structure can not be built at this isolated site for less than $5,000. It is recommended that an appropriation of that amount be made therefor.

—. *Beaufort Harbor, North Carolina.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

The harbor of Beaufort, N. C., is the only one of importance between Chesapeake Bay and Wilmington, N. C., a distance of some 200 miles. It is the natural outlet to the inland commerce of northern and middle North Carolina, and affords a refuge for vessels overtaken by storms on this exposed coast. A large number of coasting vessels from the North Carolina rivers and sounds pass out to sea by this harbor, thereby avoiding the dangerous navigation outside of capes Hatteras and Lookout. The annual commerce of this port is about $1,000,000. The depth of water at low tide is 13 feet 6 inches, and the width of the channel at the bar entrance is 1,000 feet. The inlet width is 7,000 feet, and there is good anchorage inside in 25 feet at low water. The channel across the bar is straight, and if properly marked by range lights it would be the safest and easiest harbor to enter between Cape Henry and Savannah. The estimated cost of establishing the necessary light is $10,000. It is recommended that an appropriation of this amount be made therefor.

REPAIRS.

Repairs, more or less extensive, were made during the year at the following-named stations:

423. Cape Henry, Va.
424. Thimble Shoal, Va.
427. Craney Island, Va.
431. White Shoal, Va.
432. Point of Shoals, Va.
433. Deep-Water Shoals, Va.
440. Cherrystone, Va.
441, 442. Cape Charles City Range, Va.
451. Bowlers Rock, Va.
457. Great Wicomico River, Va.
459. Point Lookout, Md.
460. Piney Point, Md.
463. Lower Cedar Point, Md.
464. Mathias Point Shoal, Va.
465. Upper Cedar Point, Md.
468. Jones Point, Va.
476. Sharps Island, Md.
483. Craighill Channel (front), Md.
484. Craighill Channel (rear), Md.
485. Seven-Foot Knoll, Md.
486, 487. Cutoff Channel Range, Md.
488. Fort Carroll, Md.
491. Lazaretto Point, Md.
500. Cape Hatteras, N. C.
503. Ocracoke, N. C.
517. North River, N. C.
518. Wade Point, N. C.
523. Croatan, N. C.
526. Hatteras Inlet, N. C.
528. Southwest Point Royal Shoal, N. C.
532. Pamlico Point, N. C,
534. Neuse River, N. C.

Fifth District.

LIGHT-SHIPS.

421. Cape Charles light-vessel, No. 49, entrance to Chesapeake Bay, Virginia.—This vessel was on her station throughout the year, until June 7, when she was temporarily withdrawn for needed repair, and was replaced by Bush Bluff light-vessel No. 46 as a relief. She was then docked, the sheathing on the bottom was carried up the width of one sheet forward, and repairs to the bottom were made where needed. The decks and top sides were calked. An inspirator connected to both boilers with new Kingston valve was fitted, and other repairs were made. She was found to be trimmed by the head and the necessary pig-iron ballast was stowed aft to correct this.

426. Bush Bluff light-vessel, No. 46, entrance to Norfolk, Elizabeth River, Virginia.—This vessel was removed from her station on June 7 to relieve the Cape Charles light-ship. The Coast Survey schooner *Drift* was placed on the station as a temporary light-vessel.

—. Cape Lookout Shoals light-vessel, North Carolina.—The following recommendation, made in the Board's last annual report, is renewed:

Cape Lookout shoals extend 8 miles beyond the point of the cape. There are dangerous breakers on the shoals 5 miles from the cape. When a vessel drawing more than 15 feet of water has made sufficient offing to just clear these shoals, she is 10 miles distant from the Cape Lookout light. Although this light is of the first order, shown from a tower 150 feet high, and should be seen a distance of 18 miles under favorable circumstances, it may happen during thick or hazy weather that a mariner may fail to see it in time to avoid that line of shoals. A light-ship of the improved model now constructed for use at exposed stations and provided with a steam fog signal, to cost $70,000 approximately, would be a valuable aid to navigation, if placed near the southern extremity of the shoals. It is therefore recommended that an appropriation of that amount be made therefor.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

421. Cape Charles light-vessel, No. 49, entrance to Chesapeake Bay, Virginia.—This 12-inch steam whistle was in operation 269 hours during the year, and consumed about 25 tons of coal.

423. Cape Henry, entrance to Chesapeake Bay, Virginia.—This first-class steam siren, in duplicate, was in operation some 256 hours during the year, and consumed about 13 tons of coal.

426. Bush Bluff light-vessel, No. 46, entrance to Norfolk Harbor, Elizabeth River, Virginia.—This 12-inch steam whistle was in operation some 100 hours during the year, and consumed 6 tons of coal.

DAY OR UNLIGHTED BEACONS.

The fourteen day beacons are in need of much repair. They will receive attention.

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BUOYAGE.

There had been so many mild winters in succession that the iron buoys in exposed places had not been taken up, except in the Potomac River. The freeze set in soon after January 1, so there was then no time to take any of them up. With very few exceptions these iron buoys were carried away by the ice. All have been recovered except two bell buoys and one or two cans, but many were damaged. The tender *Violet* was under repairs and unavailable for duty until February 27, when the *Holly* had to be laid off for very urgent repairs. So at no time during this crisis was more than one tender available for duty. Had the new tender *Maple* been delivered in October, 1892, according to contract, the damage done to the buoyage by the exceptionally severe winter could have been more readily repaired. In the sounds of North Carolina the thirty-six pile buoys carried away were replaced by spar buoys. On March 10 a lighted buoy was placed off the site of Wolf Trap lighthouse, and upon June 30 the tender *Holly* was anchored there as a temporary light-vessel, when the buoy was removed. A temporary light was established on the wreck of Solomons Lump light-house in June. The piling, or braces, were injured by ice at Smith Point, Laurel Point, and Hatteras Inlet.

WORKING PLANT.

A scow, 50 feet long and 22 feet wide, equipped with a steam piledriver and all appurtenances, was built at the Lazaretto depot during the year. It is of heavy yellow pine, with white-oak knees, strongly put together, and it is well adapted to the purpose for which it is designed.

DEPOTS.

Lazaretto Point, Baltimore, Maryland.—In July and August some repairs were made to the buildings at the depot. During the summer the sea wall at the south end of the depot was somewhat undermined. The removal of an adjacent private wharf widened the channel, and steamers began to pass nearer the depot wharf. The wash from them took effect upon the base of the wall. The sea wall was protected by a line of sheet piling secured to oak piles driven in front of the wall for a distance of about 200 feet. The space between this wooden revetment and the sea wall was decked over, forming an addition to the wharf area of about 3,000 superficial feet. Thus, besides protecting the water front, a substantial increase of wharf room was obtained. The depot is in good condition.

The following recommendation, made in the last three annual reports, is renewed:

Attention is invited to the necessity of providing a dwelling at this depot for the accommodation of the depot keeper and his family. Their quarters in the ware-

Fifth District.

house are unsuitable and uncomfortable, and even were the rooms not required for other purposes it would cost nearly as much to make them comfortably habitable as it would to build a new dwelling. About one-third of the space on the upper floor is reserved for the use of custom-house inspectors, and the large and increasing amount of work on hand in the district demands the use of all storage and shop room available. The depot keeper must be constantly on the spot, and can not live away from the premises. There is ample room on the Government tract for such a building as is required, and it can be built for $2,500. An appropriation of this amount is earnestly recommended.

Point Lookout, Maryland.—In April thirty-eight piles of the wharf were covered with yellow metal to protect them from the ravages of the ship worm. Chafing by the ice during the past severe winter rendered this work necessary. The depot is in good order.

Portsmouth, Virginia.—The dwelling is entirely too small. The coal and buoy sheds and outhouses are greatly out of repair. Much of the woodwork, including the framing of the houses and sheds, is rotten, and in places entirely gone. In the engineer's storehouse the level of the floor is below the level of the ground of the adjoining property, and the lower ends of the boarding are entirely gone. The floor should be raised at least one foot and the house repaired. The underpinning of many of the coal and buoy shed posts is rotten, and it will not be long before the sheds will be dangerous. The wooden flooring of the yard abutting the wharf is entirely worn out and needs replacing immediately. The wharf needs replanking in places, and many of the fender piles are entirely rotted out.

To make the repairs suggested and to extend the present wharf along the water front recently acquired by purchase, will cost, it is estimated, $40,000, and an appropriation of that amount is recommended.

Washington, North Carolina.—No repairs were made. The keeper's dwelling needs painting and repairing; the fence and board walk require renewing. The wharf should be partly rebuilt and coal and boat sheds should be erected.

TENDERS.

The Holly.—This vessel was withdrawn from service as a tender on June 6, preparatory to placing her on duty as a light-vessel off Wolf Trap Shoal, Chesapeake Bay, Virginia. During the year she steamed 12,628 miles, consumed 875 tons of coal, made 275 visits to light-stations, and delivered 125 tons of coal and 54 cords of wood. She also attended to 368 buoys. Fire was hauled under her boilers 30 days during the year. The crew was employed 74 days at buoy depots cleaning and painting buoys.

The Violet.—This tender steamed 12,167 miles, consumed 626 tons of coal, worked 541 buoys, built 4 beacons, repaired 12 beacons, visited 196 lights, delivered 257 tons of coal and 96 cords of wood, rationed

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11 lights, and was 67 days under repairs. The crew was employed 20 days at the Portsmouth buoy depot cleaning and painting buoys.

The Bramble.—The hull and machinery of this steam launch were recently repaired, and she is now in good order. The gas tank for supplying the beacons in Currituck Sound was also thoroughly overhauled and repaired.

The Jessamine.—This steamer was chiefly employed during the year in construction of Sharkfin Shoal and Maryland Point light-houses and North River Bar beacons; in the repairs of Seven-Foot Knoll, Craighill Channel, Cape Charles City, Point Lookout, Blakistone Island, Choptank River, Piney Point, Lower Cedar Point, Upper Cedar Point, Mathias Point, Old Plantation Flats, Solomons Lump, Janes Island, Wades Point, North River, Croatan, Roanoke Marshes, Cape Hatteras, Hatteras Inlet, Ocracoke, Southwest Point Royal Shoal, Neuse River, Pamlico Point, Craney Island, Watts Island, Deep-Water Shoals, Jordan Point, Point of Shoals, and White Shoal light-stations, and beacon lights Nos. 4, 6, 7, and 8. She was also employed in transporting commissioners to Smith Island to value and survey the new Cape Charles light-house site; in transferring the illuminating apparatus and other portable property from the Clay Island and Lambert Point discontinued stations to Lazaretto depot, and in making borings at Wolf Trap, Solomons Lump, and Hog Island to ascertain the character of the foundations for the proposed new works. In August, October, February, April, and May short intervals were occupied in necessary repairs to the vessel, including twice docking, cleaning and painting the hull with germicide paint, repairs to keel shoe, hoisting engine, steering gear and wheel buckets. The greater part of January she was ice bound in the harbor of Baltimore. During the year she steamed 6,589 miles and consumed 554 tons of coal.

The Thistle.—This little steamer was engaged in towing scows loaded with material for the construction of the new light-houses and for the repair of light-stations in North Carolina and the James River; in making repairs at Thomas Point Shoal and Watts Island light-stations and Point Lookout depot; in general attendance upon working parties in the district, and in the examination of Roanoke Marshes light-house to determine as to the damage done by colliding barges. While on the way to Baltimore from Currituck Sound her shaft and propeller were injured by a submerged log and had to be replaced. Repairs were also made to her boiler and machinery, to the metal on her hull, and to the woodwork and calking of her deck. While employed in the work above outlined she steamed about 6,500 miles with a consumption of some 214 tons of coal.

The Maple.—This new steam tender was delivered by the contractors at the buoy depot, Portsmouth, Va., on May 26, 1893. Since then she has been actively employed with the exception of a short time, when

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she was laid off to have a new derrick boom made and to have the bottom cleaned and painted. The boom furnished with the vessel was too short. The vessel is a twin-screw propeller. Her length over all is 164 feet. Her length on the water line is 155 feet. She has 30 feet beam. The depth from the top of the keel to the top of the beam is 11 feet 10 inches. She has two compound fore-and-aft surface-condensing engines with cylinders 16 inches and 31 inches diameter and 24 inches stroke. They have 650 indicated horse power. There are two cylindrical single-ended steel boilers, 12 feet long with a diameter of 11 feet 9 inches. They are heated by two Fox's corrugated furnaces. The steam pressure is 100 pounds. She is fitted with a steam hoisting fore-and-aft engine, a Globe steam steering-gear, an American Ship Windlass Company's steam windlass, a hand pump-brake windlass, and with electric light appliances for search light and for all rooms and compartments in the vessel. She is schooner-rigged and has a dingy, a gig, and one cargo boat. This vessel was in service twenty-four days during the year; steamed 850 miles, consumed 60 tons of coal, attended to 12 buoys, and visited 7 light-houses. She also towed Light-Vessel No. 46 to Cape Charles and towed Light-Vessel No. 49 from Cape Charles to Portsmouth buoy depot, Va., and afterwards to Newport News, Va., for repairs.

SIXTH DISTRICT.

The sixth district extends from New River Inlet, North Carolina, to and including Jupiter Inlet, Florida, and includes all the aids to navigation within these limits on the coasts and in the bays, rivers, and harbors of North Carolina, South Carolina, Georgia, and Florida.

Inspector.—Commander James G. Green, U. S. Navy, until June 24, 1893; Lieut. Commander M. R. S. Mackenzie, U. S. Navy, from June 24, 1893.

Engineer.—Capt. Eric Bergland, Corps of Engineers, U. S. Army.

In this district there are—

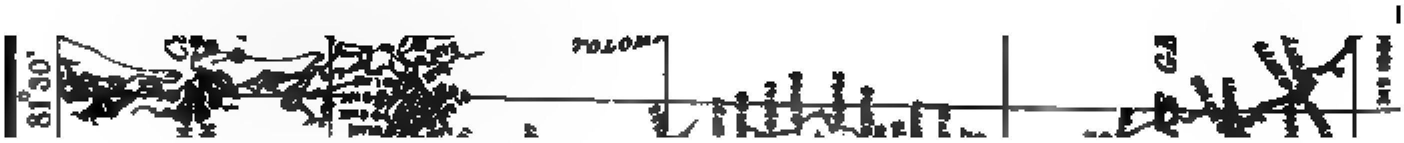
Light-houses and beacon lights, including 139 post lights	205
Light-ships in position	3
Day or unlighted beacons	32
Fog signals operated by steam	2
Fog signals operated by clockwork	3
Whistling buoys in position	6
Bell buoys in position	15
Other buoys in position	299
Steamer *Wistaria*, buoy tender and for inspection and supply	1
Schooner *Pharos*, for construction and repair	1

Quarterly inspections were made of each station, wherever practicable. With one or two exceptions, the general conditions as to cleanliness and neatness of the light-stations in this district, is creditable.

LIGHT-HOUSES.

—. *Cape Fear, seacoast of North Carolina.*—The following statement, which was made in the Board's last four annual reports, is renewed:

The shoals forming the continuation of this cape for about 18 miles to the southeast are dreaded by shipmasters only a little less than those at Cape Hatteras. At present a light ship near the outer extremity of the shoals warns vessels of danger and gives them a good point of departure. This aid to navigation can not be dispensed with; but it is not sufficient to insure adequate protection to the large number of domestic and foreign vessels attracted to this point by the considerable and increasing trade of the neighboring port of Wilmington, N. C., because of the small area lighted by it, and because of its liability to be set adrift from its moorings during heavy storms, which is the very time when its light is most needed. The present Cape Fear light (Bald Head), on account of its inland position and want of height, does not cover the shoal, and therefore does not give sufficient warning to vessels when the light-ship may have drifted from her moorings. A first-order light-house built on the pitch of Cape Fear, with a radius of 18¾ miles of light, would be seen so far as to give timely warning, and the fact of being near enough to the coast to see it would be a sufficient indication that the observer should make a better offing. Other reasons for a first-order light-house here may be found in the better protection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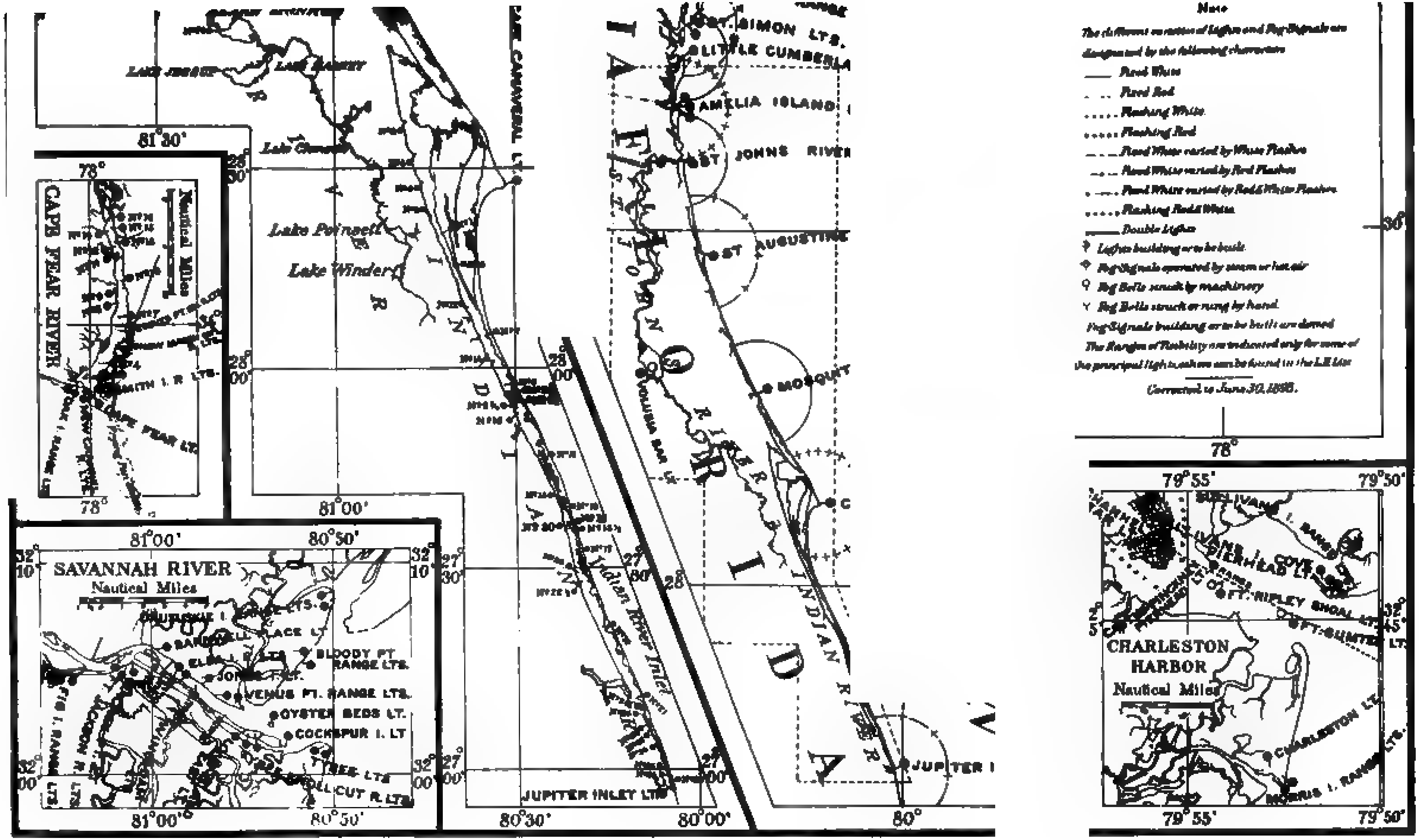

Note
The different varieties of Lights and Fog Signals are designated by the following characters
Fixed White
Fixed Red
Flashing White
Flashing Red
Fixed White varied by White Flashes
Fixed White varied by Red Flashes
Fixed White varied by Red & White Flashes
Flashing Red & White
Double Lights
Lights building or to be built
Fog Signals operated by steam or hot air
Fog Bells struck by machinery
Fog Bells struck or rung by hand
Fog Signals building or to be built are dotted
The Ranges of Visibility are indicated only for some of the principal lights, others can be found in the L.H. List
Corrected to June 30, 1893.
CHARLESTON HARBOR
Nautical Miles
SAVANNAH RIVER
Nautical Miles
CAPE FEAR RIVER
Nautical Miles
ST. SIMON LTS.
LITTLE CUMBERLAND
AMELIA ISLAND
ST. JOHNS RIVER
ST. AUGUSTINE
MOSQUITO
VOLUSIA BAR LT.
CAPE CANAVERAL LT.
JUPITER INLET LTS.
Indian River Inlet
INDIAN RIVER
ST. JOHNS RIVER
FLORIDA
Lake Poinsett
Lake Winder
BLOODY PT. RANGE LTS.
VENUS PT. RANGE LTS.
OYSTER BEDS LT.
COCKSPUR I. LT
FIG I. RANGE LTS.
SMITH I. R. LTS.
CAPE FEAR LT.
CHARLESTON LT.
MORRIS I. RANGE LTS.
FT. SUMTER LT.
FT. RIPLEY SHOAL LT.

Sixth District.

it would afford to the bight lying north of the cape, which has been left dark since the discontinuance of Federal Point light-station in 1880. The proposed light would more than compensate for the one discontinued at Federal Point. It may be proper to add that there is no first-order light-house between Cape Lookout, North Carolina, and Cape Romain, South Carolina, a distance of about 170 nautical miles. Recent changes in the lighting of the entrance to the Cape Fear River have almost eliminated the Cape Fear light-house (Bald Head) as a harbor light. Its only use is that of a rear beacon to a stake light forming a range to guide up the river after crossing the bar. Upon the establishment of the proposed new light on the pitch of Cape Fear the old light might be discontinued, as the tower and the keeper's dwelling are antiquated and discreditable to the Light-House Establishment.

Urgent petitions have been presented to the Light-House Board by commercial and pilot associations of Wilmington, N. C., and by shipmasters trading to that port, which have had its careful consideration and approval.

It is estimated that a tower 150 feet high, with suitable oil room, keeper's dwellings, and outbuildings, on the pitch of Cape Fear, will cost $70,000, and it is recommended that this amount be appropriated therefor.

536. Cape Fear, entrance to Cape Fear River, North Carolina.—During the year the characteristic of this light was changed from flashing red to flashing white every 30 seconds and Funck-Heap lamps were substituted for Hains lamps. A topogrphical survey of the site was made. As it is proposed to discontinue this light upon the establishment of a first-order light-station on the pitch of Cape Fear, no further expenses were incurred at this place.

537, 538. Oak Island, mouth of Cape Fear River, North Carolina.—Funck-Heap lamps were substituted for Hains lamps. A topographical survey of the site was made.

539-558. Cape Fear River post lights, North Carolina.—The New Channel range, the Snow Marsh Channel range, and the Reeves Point Channel range are new and in good condition. The other ranges and post lights were established in 1885 and their piles have begun to decay. The piles of the Smith Island range and of Battery Island post light No. 3 will soon need to be spliced or renewed. As a new system of post lights is proposed for Cape Fear River, involving the discontinuance of the present structures above the Reeves Point range, no steps were taken for their repair.

The service of these lights was good. Most of them are in good condition and need little repair. They are indispensable aids for the night navigation of the river.

—. Range lights for new dredged channels in the Cape Fear River, North Carolina.—The following recommendation, made in the Board's last annual report, is renewed:

The Board recommended the discontinuance of ten of the present post lights in the upper part of the Cape Fear River, and the establishment of twenty-four new post lights, which, in connection with certain other ranges already established, would con-

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stitute a system of ranges to guide vessels from the Cape Fear entrance to Wilmington, N. C., through channels dredged to a depth of 20 feet at mean low water. As vessels are now carried by ranges one-half the distance between the entrance and Wilmington, and then left without further adequate guidance, the Board is of opinion that to complete the usefulness of the aids to navigation in the lower part of the river similar aids should be provided to guide them to their port of destination. It is estimated that this can be done at a cost not to exceed $3,105, and it is recommended that an appropriation of that amount be made for this purpose.

561. *Cape Romain, seacoast of South Carolina.*—A topographical survey was made of the site. The tower was carefully tested instrumentally, but no additional deflection from the vertical was detected.

563. *Bull Bay, north end of Bull Island, South Carolina.*—Funck-Heap lamps were substituted for Hains lamps, and a topographical survey was made of the site. The sea has in the past two years made rapid encroachments on this station, and if it continues two years more the light-house will be in great danger. The value of the structures does not warrant a large expenditure for the protection of the site; hence, in the event of continued erosion, it is proposed that a new site be purchased and a new light-house erected rather than that an attempt be made to preserve the site.

565, 566, 567. *Charleston and Morris Island Ranges, South Carolina.*—The spring tides of June 15 were so high as to reach beyond the landward side of the south front beacon and to undermine it to such an extent as to throw the structure 5 inches out of level. The beacon was at once restored to its proper level; but if the erosion of the south end of Morris Island continues as in the past year, it will soon be necessary to move both of the front beacons of the Morris Island ranges about 300 feet nearer to the tower. The station is otherwise in fairly good condition. A topographical survey was made of the site.

568, 569, 570. *Sullivans Island Ranges, Charleston Harbor, South Carolina.*—This station was extensively repaired during the year. Funck-Heap lamps were substituted for Hains lamps. A topographical survey of the site was made.

—. *St. Philip's Church Steeple, rear beacon of Swash Channel Range, South Carolina.*—During the year the deepening of the Swash Channel, which resulted from the progress of the stone jetties in course of erection for the improvement of this channel, was so great as to make it the best entrance into Charleston Harbor and to call urgently for lights to guide through it. A part of the improvement consisted in dredging a straight cut across the bar. The beacon on Fort Sumter and the steeple of St. Philip's Church in the city of Charleston, gave the range for dredging operations. When the call for lights came, the use of Fort Sumter light, in connection with a light in the St. Philip's Church steeple naturally suggested itself as a night range through the cut, which could be made temporarily effective at once until an appropriation could be secured to erect a rear beacon. The vestry of St. Philip's

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Church gave permission for the use of their steeple upon the payment of a yearly rental of $300. A pedestal was built for the support of a locomotive headlight lantern and reflector, and gas pipes were run from the city main to an argand gas-burner placed in the focus of the reflector 140 feet above mean sea level. The gas is lighted by an electric apparatus located at the base of the steeple near the gas meter, with connecting wires running to the burner. This new light is in good order and works well. As the permission granted by the vestry of the church extends only to December 31, 1894, it will be necessary to erect before that date a beacon to take the place of the light in the steeple. There is no suitable location between Fort Sumter and the city of Charleston for the site of this beacon, and it is suggested that a site be purchased at the intersection of the range line with the water front of the city, and that upon this a structure similar to the rear beacon of the Paris Island range, South Carolina, be erected, with focal plane 120 feet above base. It may be necessary to reduce at the same time the height of the focal plane of Fort Sumter light.

574. *Sullivans Island Cove Pierhead, Charleston Harbor, South Carolina.*—This structure was during the year so much injured by the *teredo* that a new one, sheathed with yellow metal, became necessary and was built.

577, 578. *Hilton Head Range, seacoast of South Carolina.*—Funck-Heap lamps were substituted for Hains lamps.

585, 586. *Tybee Light and Beacon, Tybee Island, Georgia.*—Funck-Heap lamps were substituted for Hains lamps.

587, 588. *Cockspur Island and Oyster Beds Beacons, Savannah River, Georgia.*—The boat landing on the south channel of the Savannah River was extended and repaired with piles sheathed with yellow metal. Six casemates in Fort Pulaski were fitted up with partitions, doors, windows and blinds, embrasure shutters, and closets for the accommodation of the two keepers. Funck-Heap lamps were substituted for Hains lamps.

589, 590. *Tybee Knoll Cut Range, Savannah River, Georgia.*—Extensive shoaling having occurred in the Savannah River opposite this station, it became necessary to extend the wharf 145 feet toward the channel. While this was being done, the elevated plank walks were repaired. A fireproof oil house, 9 by 11 feet in the clear, was built. It has ventilators and drain pipes, and shelves sufficient to receive four hundred and fifty 5-gallon oil cans.

593, 594. *Venus Point Range, Savannah River, South Carolina.*—The boat landings at both beacons were extended on account of the shoaling of the Savannah River, that of the front beacon 25 feet on four piles, both sets sheathed with yellow metal, and that of the rear beacon 60 feet on eight piles.

About 400 running feet of elevated plank walk were repaired. The changes in the channel of the Savannah River, caused by the con-

Sixth District.

struction of certain stone jetties by the United States Government for its improvement, have caused its permanent shoaling opposite the front beacon of this range to such an extent as to make it economical to discontinue the wharf and elevated plank walk which have connected this beacon heretofore with the river and to connect it directly with the rear beacon by a low plank walk 6,000 feet long. This will be done during the present fiscal year.

595. Jones Island, Savannah River, South Carolina.—The boat landing was extended into the river 24 feet on four sheathed piles.

604, 605. Fort Jackson Range, Savannah River, Georgia.—A fireproof oil house was built during the year.

—. Saint Catherine Sound, seacoast of Georgia.—An appropriation was made by the act approved March 3, 1893, for the establishment of a fourth-order light-house on this sound. A survey and plat of the selected site on St. Catherine Island was plotted, and negotiations for its purchase were begun. No offer to sell could be obtained from its owner, so proceedings in condemnation were instituted to acquire title through the United States courts.

608, 609. Sapelo Light and Beacon, entrance to Doboy Sound, Georgia.—The front beacon was moved 8 feet southwesterly to accommodate the range to the changes in the channel. Funck-Heap lamps were substituted for Hains lamps.

610, 611. Wolf Island Range, entrance to Doboy Sound, Georgia.—The front beacon was moved 11 feet to the southward to accommodate the range to the changes in the channel. New sills were put under the beacon, and the boathouse was moved and erected on piles sheathed with yellow metal.

—. Doboy Sound, seacoast of Georgia.—The following recommendation, which was made in the Board's last four annual reports, is renewed:

> The two ranges now established take vessels to the intersection of the Wolf Island and the Sapelo Island ranges, and leave them there without guidance in a very dangerous position if they anchor, and with the Knuckles on one side and the Chimney Spit Shoals on the other if they proceed. It is therefore recommended that the front beacon of the present Sapelo Island range be removed to a point where it may be used as a rear beacon of a new range, and that a stake light be established to serve as a front beacon for this new range; also that another range be established higher up the sound, to consist of a steamer lens and lens lantern, respectively, for the rear and front beacons. It is estimated that these new ranges, including sites, will cost $1,500.

613. Saint Simon Beacon, Georgia.—An appropriation having been made by Congress for the establishment of a small beacon, which, in connection with St. Simon main light, would make a range to guide across the bar at the entrance of St. Simon Sound, Georiga, a site was selected and an effort made to purchase; failing in this, proceedings in condemnation were commenced. The case will probably come up in the United States district court in November next.

Sixth District.

—. *The inside passage from Savannah, Georgia, to Fernandina, Florida.*—In its last four annual reports the Board recommended that it be empowered to erect and maintain twenty-five post lights, in order to facilitate the navigation of the inland passage from Savannah to Fernandina, at an estimated cost of $4,000, and that the appropriation for lighting of rivers be increased by that amount to permit of the establishment and maintenance of these lights. This recommendation is renewed.

615, 616. Amelia Island Range, Fernandina entrance, Florida.—The channel across the bar at the Fernandina entrance, through which this range was intended to guide vessels, has shifted during the last few years so widely that it was found impracticable to accommodate heavy structures to its frequent changes. The lights thus became a source of danger rather than of assistance to navigation, and they were therefore discontinued in December, 1892. In order that the entrance should not be closed to vessels at night during the period of this discontinuance, temporary ranges consisting of light triangular structures carrying tubular lanterns, which could be easily and rapidly moved from place to place as the changes in the channel might demand, were substituted for the permanent beacons, and have given satisfaction.

617, 618. Tiger Island North Range, Fernandina entrance, Florida.—In November, 1892, title was acquired by condemnation to the two sites needed for this range. A wooden triangular skeleton structure, carrying a tubular lantern, was built at each of the sites and they were connected with each other by an elevated plank walk, 1,490 feet long.

619, 620. Tiger Island South Range, Fernandina entrance, Florida.—In November, 1892, title was acquired by condemnation to the two sites needed for this range. A wooden triangular skeleton, carrying a tubular lantern was built at each of the sites and they were connected with each other by an elevated plank walk, 470 feet long.

—. *Mount Cornelia, mouth of St. Johns River, Florida.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

> The present light-house at the mouth of St. Johns River, Florida, is of the third order, and for years there have been complaints that it was inefficient as a seacoast light, while as a harbor light the new jetty channel will soon require the establishment of a range to which this structure, on account of location, can not be adapted. It has a small base and stands on marshy ground, and can not be increased sufficiently in height to make it a good seacoast light. A site peculiarly adapted to the erection of a light-house is found near the mouth of the river, on its north side, on Mount Cornelia, which has an extreme elevation of 62 feet above mean sea level, and on which a good foundation with sufficient area for a modern light-station could be had at an elevation of 50 feet above mean sea level. A first-order light-house, with focal plane 150 feet above its base, erected at this point, would have a focal plane 200 feet above mean sea level and a 20-mile radius of light. This would intersect with the adjacent seacoast light to the southward, situated at St. Augustine, Fla., better than the present St. Johns River light does, and would practically cover the area now lighted by the adjacent seacoast light to the northward, situated on Ame-


81°30'

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beacons in general is poor, and it will be necessary to renew the greater part of them during the coming year.

REPAIRS.

Repairs, more or less extensive, were made during the year at the following-named stations:

571. Fort Sumter, S. C.
612. Saint Simon, Ga.
621. Amelia Island, Fla.
743. Jupiter Inlet, Fla.

LIGHT-SHIPS.

535. Frying-Pan Shoals light-vessel, No. 53, off Cape Fear, North Carolina.—This vessel is in good order and is well kept. A new steel propeller vessel, with a 12-inch steam whistle, replaced light-vessel No. 29, at Frying-Pan Shoals. The old vessel was towed by the tender into Charleston, and is now kept in that port as a relief light-vessel.

564. Rattlesnake Shoal light-vessel, No. 34, off Charleston, S. C.—This vessel is in good condition and is kept in good order. Light-vessel No. 38, on Rattlesnake Shoal, was condemned and sold. She was replaced by light-vessel No. 34, which vessel, after being removed from Martins Industry Shoal, was put in thorough condition before being placed on Rattlesnake Shoal.

NOTE.—This vessel was torn from her moorings and driven ashore by the cyclone of August 27 and 28, 1893. The Board, by letter of September 11, 1893, constituted the inspectors of the fourth, fifth, and sixth light-house districts a board to ascertain and report the cause of this wreck. The following account of the wreck is condensed from the evidence given before this board of investigation:

John McCormick, keeper or captain of Rattlesnake Shoal light-vessel, testified that on August 27 the storm came from the east. The gale commenced between 11 a. m. and noon, and the sea immediately began to break on board. Both boats were stranded, one at 1 p. m. and the second at 4 p. m. The boats were carried high on the davits, not swung in. The freeing ports were all triced up, and the hatches were battened down at the beginning of the gale. All sails were bent except the foresail, and that was all ready to bend. The large mooring parted at 7 p. m.; this was a $2\frac{1}{8}$-inch chain with a mushroom anchor, and 95 fathoms of chain were outside the hawse pipe. The chain cable had been examined within three days. The deep-sea lead was then over the side and was attended by the master with the assistance of the mate. Before the chain cable parted, the second anchor was washed overboard, when the shank painter and ring stopper parted, and 35 fathoms of ranged cable ran out, so that the second anchor was already down when the first cable parted. They veered to 95 fathoms on this second chain, which measured $1\frac{7}{8}$ inches for 30 fathoms from the mushroom anchor, and from that point $1\frac{1}{2}$ inches. The pumps were

looked after when the vessel went ashore. There was then only 10 inches of water in her. The second cable parted at 1 a. m., August 28, and the vessel drifted on to Long Island, taking the beach at 5 a. m. The smaller cable parted in the hawse pipe; the larger cable parted well outside. The captain testified that this was the longest blow he had ever had on this station, which he had occupied for nineteen years. He further stated that from all his experience in gales of wind, and he had been going to sea for over fifty years, this was the worst gale he had ever experienced. When asked as to how they got on shore, he replied that Antone Jorgensen, seaman, swam ashore with the lead line, and made a hauling line of it, and the crew hauled themselves ashore, and they hauled him, the keeper, ashore.

The mate of the light-ship, in his testimony, corroborated that of the captain, and added that they set the staysail, which stood five minutes, but it put her head on to the beach. Jorgensen, he said, swam ashore with the deep-sea lead line and made it fast to a stump, when the seamen hauled themselves ashore. The mate then bent the line on to the captain when he was hauled ashore, but was nearly dead when he got there. The investigating board reported that the stranding of the ship was due to the parting of both cables in a cyclone of unusual violence, accompanied by an unprecedented sea, and that it was not due to any lack of precaution on the part of any one.

After the wind and sea had subsided an examination was made, when it was found that the vessel was hard and fast on shore, and that it was impossible to remove her with ordinary appliances. Bids were called for from the principal wrecking companies of the country, and a contract was awarded to the lowest bidder, in the sum of $5,500, to haul the ship off and deliver her at Charleston.

576. Martins Industry light-vessel, No. 1, off Port Royal entrance, South Carolina.—This vessel is in good condition and is kept in good order. Light-vessel No. 1, with a 12-inch steam whistle, replaced light-vessel No. 34, on Martins Industry Shoal.

—. *Relief light-vessel, No. 29.*—This vessel is retained in Charleston Harbor as a relief vessel. She is in poor condition and needs extensive repairs.

DAY OR UNLIGHTED BEACONS.

There are in this district thirty-two day or unlighted beacons, which are in good condition.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

535. Frying-Pan Shoals light-vessel, No. 53, North Carolina.—Since January 1, 1893, this 12-inch steam whistle was in operation some 33 hours, and consumed some 2 tons of coal.

Sixth District.

576. Martins Industry light-vessel, No. 1, South Carolina.—This 12-inch steam whistle was in operation about 118 hours, and consumed some 6 tons of coal, after January 1, 1893.

BUOYAGE.

The buoyage of the district is in good condition. The buoys were relieved as often as was found practicable and necessary. Repairs were made to buoys at a reasonable cost. The local pilots employed at the entrance to Winyah Bay, S. C., Fernandina, St. Johns River, and St. Augustine, Fla., kept the buoys in position at those places.

DEPOTS.

Castle Pinckney, Charleston Harbor, South Carolina.—Twenty fender piles were supplied and driven on the head and sides of the wharf at this depot. The storehouse and custodian's dwelling are in good condition, but both the piles and superstructure of the wharf will in the course of two years require extensive renewals. During the present year 12 wharf piles, 5 fender piles and 10,000 square feet of new decking will be required. The stores, supplies, etc., are well cared for.

NOTE.—This depot was wrecked by the cyclone of August 26 and 27, 1893, and most of its contents were destroyed.

The following extract from the joint report of the inspector and engineer of the sixth light-house district, dated September 12, describes the destruction of the old depot and shows the necessity and gives the cost of a new depot:

The effect of the storm upon the depot was, in brief, to undermine the foundations of the storehouse, tear off its weather-boarding, lay open its contents to the action of the winds and sea, and to scatter its stores in every direction and for long distances. On the wharf, 60 by 200 feet, a great part of the decking was torn loose from the joists, and in some measure the joists were broken, and in places even the caps were parted from the piles, with the result of dropping into the water below sinkers, anchors, and buoys. Boats stored on the land in rear of the fort, high above the ground, were washed away and lost, and even the keeper's dwelling, which was built several feet above the general level of the site, was in serious danger from the waves.

As the storm did great injury to many light-stations, carried two light-vessels from their moorings, and drifted many buoys from their positions, there was a great demand made upon the depot for stores and supplies at the very time that its defects and weakness had deprived the district of its reserves.

The lesson taught by all this is, that our depots should be so built as to be able to resist the greatest storms, and so located as to permit of the construction of solid buildings on firm foundations. That such structures can be built on the water fronts of the district is evidenced by the present condition of the only two granite piers in Charleston, and of the granite sea wall along the east front of the Battery, which are as solid as before the storm. But such structures can not be built at Castle Pinckney without so great an expenditure for foundations as would make them cost much more than similar buildings on a proper site with the cost of site added to them, because the island upon which Castle Pinckney stands is nothing

Sixth District.

but a *mud flat*, and was used by the Light-House Establishment only because, while an urgent necessity existed for a depot, no funds were available for the purchase of a proper site, and the War Department permitted the occupation of the Castle Pinckney reservation, without charge.

The building of a fort at this point, at great cost for foundation, was justified by its position in the system of defense of Charleston Harbor, but has been abandoned by the War Department. It is supported on piles, but has sunk, and with it the island in the vicinity, until the surface of the latter is below high-water level, and this subsidence has continued more or less since the depot was established in 1879, necessitating the building up from time to time of the surface with sand taken from the fort, and a system of wooden platforms with riprap stone protection of dwelling and storehouses, which is in itself a source of expense in maintenance. Besides the great exposure of the wharf structure to easterly winds and seas, it has been found necessary on two occasions to extend it farther into Folly Island Channel, in consequence of the shoaling up at its head, and it is probable that further extension will be required in the future from the same cause.

A minor unsuitableness or inconvenience, but a very real one, comes from its separation by nearly a mile of water from the nearest part of Charleston, over which there is no public ferry or means of communication.

For all these reasons it seems fitting that a better depot should be provided for this district, and if a change is to be made no more favorable time for it, pecuniarily, than the present is likely to be found, because the old depot now requires repairs estimated at $6,814, of which $4,500 might be saved if it is determined to abandon it, and because of the dismantled and broken condition of the wharves on the water front of Charleston, which, before permanent repairs are made to them, could probably be purchased at lower prices than will rule again for some years.

If a change is approved by the Board, and in our opinion a change must come sooner or later, we would respectfully recommend that adequate provision be made for a first-class depot, all the structures of which should be of the best quality and of brick, iron, and granite or concrete. This would demand a site with a water front of 180 feet, to allow for two wharves 40 feet wide, with a slip between of 100 feet, and a depth inland, of say, 150 feet for the convenient location of offices, storehouse, coal shed, oil and paint house, and lamp shop, and such a piece of property could probably be purchased *now* for between $25,000 and $30,000.

The following approximate estimate is submitted, viz:

Two twin docks partly on iron-screw and partly on iron-sleeve piles, with iron superstructure excepting decking, each to have 8,000 square feet of surface, at $25,000	$50,000
One iron coal shed, 3,200 square feet of surface, with automatic loading and unloading railway, complete, with cars	12,000
One iron boat shed for spare boats	800
One brick and iron fire-proof oil and paint house	1,000
One brick depot-keeper's dwelling	4,000
One brick lamp shop of 1,200 square feet floor surface, with tools and furniture	5,000
One brick storehouse, with offices on second story, 40 feet by 80 feet in plan, furnished	20,000
One sea wall 350 feet long, of granite or concrete, at $50 per lineal foot	17,500
	110,300
Site, say	$30,000
Add 10 per cent for contingencies	14,030
Total	154,030

Sixth District,

It is estimated that the legal expenses may bring the total cost of the depot up to $155,000, and it is recommended that an appropriation of this amount be made for the purchase of a site for a depot at or near one of the dock piers at Charleston, S. C., and for the erection thereon of suitable buildings.

TENDERS.

The Wistaria.—This steamer replaced and relieved 316 buoys, painted 365, repaired 93, and recovered 5 buoys, and did 36 days' work at the depot. She transported the inspector quarterly, to inspect light-stations and light-ships, and delivered to the light-ships some 173 tons of coal and 11 cords of wood. She steamed some 10,000 miles, with an expenditure of about 564 tons of coal and 15 cords of wood. She was 63 days in motion, 138 days under banked fires, and 164 days without fires under the boiler. Her engines were overhauled and lined up, and various miscellaneous repairs were made. She was hauled out on the dry dock, when her bottom was cleaned and painted. Her garboard strakes were found in bad conditon.

The Pharos.—This schooner was actively employed in repairs, construction, and surveys, as follows: During July she moved the front beacons of the Sapelo and Wolf Island ranges, put new sills under Wolf Island front beacon, and moved and reërected the boathouse on piles sheathed with sheet zinc. During August and September she put the rear beacon of the Sullivans Island range on a new foundation of nine piles sheathed with yellow metal and repaired the dwelling, outhouses, and fences. During October she repaired the dwelling at Fort Sumter, made examination for the location of St. Simon beacon, Georgia, and also for Tiger Island, north and south ranges, and for a temporary range on Amelia Island, Florida. During November she extended the wharf and the elevated plank walks at Tybee Knoll Cut light-station, Georgia. During December she repaired the boat landing at Cockspur Island, Venus Point, and Jones Island, Savannah River, Georgia. During January and February she carried men and material to Amelia and Tiger Islands, Florida, and constructed the three ranges on those islands. During March she transported material for and built oil houses at Tybee Knoll Cut and Fort Jackson ranges, Georgia. During April she was employed until the 17th in making inspections of various light-stations. On April 18, she was dismasted at sea, near Charleston, S. C., losing her mainmast, foremast, main topmast, and fore topmast. She was supplied with new masts on May 30, and on June 19, being in readiness for sea, she was loaded with material and the outfit of the working party destined for the removal of Cape Canaveral light-station to its new site. She sailed for Cape Canaveral on June 26, and arrived on June 30.

.SEVENTH DISTRICT.

The seventh district extends from just south of Jupiter Inlet, Florida, to the mouth of the Perdido River, Florida, and includes all aids to navigation on the Atlantic and Gulf coasts of Florida within these limits.

Inspector.—Commander William B. Newman, U. S. Navy.

Engineer.—Maj. James B. Quinn, Corps of Engineers, U. S. Army.

There are in this district—

Light-houses and lighted beacons	34
Day or unlighted beacons	36
Whistling buoys in position	3
Bell buoys in position	5
Other buoys in position	239
Steamer *Laurel*, buoy tender and for supply and inspection	1
Steamer *Arbutus*, for construction and repair in the seventh and eighth districts.	1

LIGHT-HOUSES.

—. *Hillsboro Inlet, off Hillsboro Point, between Jupiter Inlet and Fowey Rocks lights, Atlantic coast of Florida.*—The following recommendation, which was made in the last eight annual reports of the Board, is renewed, with the recommendation that $90,000 be appropriated for this purpose:

The establishment of a light at or near Hillsboro Point, Florida, would be of great assistance to all vessels navigating these waters. Steamers bound southward, after making Jupiter Inlet light, hug the reef very closely to avoid the current. The dangerous reef making out from Hillsboro Inlet compels them to give it a wide berth and to go out into the Gulf Stream. Vessels coming across from the Bahama Banks would be able to verify their position if a light were placed here; a difficult matter in case they fail to make Jupiter Inlet. The establishment of this light would complete the system of lights on the Florida reefs. The Board, therefore, renews the recommendation that $90,000 be appropriated for this purpose.

744. *Fowey Rocks, northern extremity of Florida Reefs, Atlantic Ocean, Florida.*—On April 30, 1893, the characteristic of this light was changed from fixed white to fixed white with three red sectors. Slight repairs to the illuminating apparatus were made.

745. *Carysfort Reef, near the edge of the Gulf Stream, Florida Reefs, Florida.*—The characteristic of this light was changed on April 30, 1893, from flashing white to flashing white with three flashing red sectors, the interval between flashes of 30 seconds remaining as heretofore.

746. *Alligator Reef, Florida Reef, Florida.*—The limits of the red sectors were altered. The change in the characteristic took effect April 30, 1893.


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Seventh District.

747. *Sombrero Key, on Sombrero Shoal, Florida Reefs, Florida.*—On April 30, 1893, the characteristic of this light was changed from fixed white to fixed white with three red sectors.

748. *American Shoal, Florida Reefs, Florida.*—On April 30, 1893, the characteristic of this light was changed from flashing white to flashing white with three flashing red sectors. The interval of five seconds remains unchanged.

749. *Sand Key, near Key West, Gulf of Mexico, Florida.*—The characteristic of this light was changed on April 30, 1893, by the insertion of two additional sectors in which the light shows fixed red, varied by red flashes. The duration of the respective periods of fixed light, of the partial eclipses, and of the flashes were not changed. A topographical survey of this reservation was made.

750. *Key West, Key West Island, Gulf of Mexico, Florida.*—The following statement was made in the Board's last two annual reports:

> The tower is of brick and in good condition. It is, however, not high enough to make it as conspicuous as it should be. Tall trees obstruct the view of the light from the northwest. It is an important light of the third order, and is a leading light for no less than seven different channels in the vicinity. The tower is but 60 feet high. It would be an immense improvement in many ways to build up the tower about 20 feet, to increase the height of the watchroom section about 3 feet, and to provide a suitable balcony.
>
> The watchroom is so low that the keeper can not stand erect in it, and the balcony is too narrow for practical purposes. The changes suggested would require the substitution of a temporary light for about a month, the construction of a new watchroom section with suitable balcony, a new pedestal for the lamp, and an increase in the height of the brickwork of the tower of about 20 feet.

Appropriation for this was made in the sundry civil appropriation act, approved on March 3, 1893. The plans and specifications for this work are now being prepared in this office. The characteristic of this light was changed on April 30, 1893, from fixed white to fixed white with three fixed red sectors. A topographical survey of this reservation was made during the year.

751. *Northwest Passage, near Key West, Gulf of Mexico, Florida.*—On April 30, 1893, the characteristic of this light was changed from fixed white with one fixed red sector to fixed white with two fixed red sectors.

752. *Rebecca Shoal, Florida Reefs, Gulf of Mexico, Florida.*—The characteristic of this light was changed on April 30, 1893, from flashing alternately red and white throughout the entire horizon, to flashing red and white, excepting from WSW. ¼ W. southward to NW. by W. ½ W., in which sector every flash is red. The interval between flashes remains unchanged.

753. *Dry Tortugas, on Loggerhead Key, the westernmost key of Tortugas group, Gulf of Mexico, Florida.*—On April 30, 1893, the characteristic of this light was changed from fixed white to fixed white with a fixed

Seventh District.

red sector. A few minor repairs were made. This station will require extensive repairs during the ensuing year.

754. Tortugas Harbor, on the SE. bastion of Fort Jefferson, Garden Key, Gulf of Mexico, Florida.—The characteristic of this light was changed on April 30, 1893, from fixed white to fixed white with three fixed red sectors.

759. Mangrove Point Beacon, in about 15 feet of water, 1⅜ miles SE. by S. from Mangrove Point.—This beacon was adapted to receive a lens lantern showing a white light, the light being established February 20, 1893.

760. Peace Creek Beacon, Charlotte Harbor, Gulf of Mexico, Florida.—This beacon was adapted to receive a lens lantern showing a red light, the light being established February 20, 1893.

—. *Live Oak Point Beacon, Charlotte Harbor, Gulf of Mexico, Florida.*—This beacon was removed February 11, 1893.

761. Egmont Key, entrance to Tampa Bay, Gulf of Mexico, Florida.—A new dwelling is needed for the assistant light-keeper. The Board estimates that it can be built for not exceeding $4,000, and it is recommended that an appropriation of this amount be made for that purpose.

—. *Tampa Bay, Gulf of Mexico, Florida.*—Congress appropriated $6,000 in the act entitled "An act for the establishment of additional aids to navigation in Tampa Bay, Florida," which was approved on July 27, 1892. Plans and specifications have been made for the work, and it is hoped that it will be finished this year.

763. Cedar Keys, on eastern end of mound on Seahorse Key, harbor of Cedar Keys, Gulf of Mexico, Florida.—A topographical survey of this reservation was made during the year.

764. St. Marks, east side of entrance to St. Marks River, Gulf of Mexico, Florida.—A topographical survey of the reservation was made.

765. Crooked River, Gulf of Mexico, Florida.—On July 31, 1888, $40,000 was appropriated for the erection of a light-house on the mainland to the westward of Crooked River, in Franklin County, Fla. The land for the site was selected and a deed of 12.2 acres, with a tracing showing the location, and an abstract of title, was sent on September 19, 1889, to the United States attorney for examination. The deed was found insufficient and condemnation proceedings were instituted. In July, 1891, the United States court-house was destroyed by fire and all the papers in the case were burned. The papers were at once duplicated and the title to this site was approved by the Attorney-General of the United States on August 22, 1892. Efforts to locate section lines have not resulted satisfactorily and the work of construction has consequently been delayed until a survey to establish the location of the lines of the reservation with respect to these lines can be made.

769. Cape San Blas, near south point of Cape San Blas, Gulf of Mexico, Florida.—A topographical survey of this station was begun, but it was

Seventh District.

not completed. No encroachment of the sea has occurred, but the advisability of removing the tower to a new site is deemed urgent. A location has been selected, but no title to the land has yet been obtained.

770. Pensacola, near Fort Barrancas, north side of Pensacola Bay, Florida.—A topographical survey of this station was made.

—. *St. Joseph Point, St. Joseph Bay, Gulf coast of Florida.*—The following recommendation, which was made in the Board's annual reports for the last five years, is renewed:

The fishing fleet on this coast is large. A southerly gale is calculated to drive these vessels upon a lee shore. The only harbor of refuge for some 60 miles is St. Joseph Bay. This is easily accessible in the daytime, but at night it is difficult of entrance without a light. The Board is decidely of opinion that it would be largely to the interests of the fishing fleet in particular, and the commerce and navigation of the Florida coast in general, that this light should be established. It is estimated that it can be done for $25,000. A bill for this purpose was favorably reported upon recently by the Senate Committee on Commerce, and the Senate inserted the item in the sundry civil appropriation bill, but as it failed of enactment the recommendation is renewed.

—. *Deer Point, entrance to Santa Rosa Sound, Pensacola Bay, Florida.*—The establishment of a beacon light here at a cost not to exceed $1,000 was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount be appropriated.

REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

755. Sanibel Island, Fla.
762. Anclote Keys, Fla.
766. Cape St. George, Fla.

DAY OR UNLIGHTED BEACON.

Live Oak Point Beacon, Charlotte Harbor, broken off by collision with a phosphate barge, discontinued as no longer necessary, was removed in February, 1893.

BUOYAGE.

A buoy was placed to mark the edge of Black Beacon Shoal, Northwest Channel, in Key West Harbor.

A temporary buoy was placed to mark a spit making out from the north sand bore, Boca Grande entrance, Charlotte Harbor.

Six buoys went adrift; three of them were recovered. Two buoys were sunk by collision, but were recovered and repaired.

A second-class can buoy was condemned as beyond repairs. The loss for the year was four buoys.

Seventh District.

DEPOTS.

Tortugas Harbor (Fort Jefferson), Gulf of Mexico, Florida.—On May 11, 1893, it was found on inspection that all the piles standing in the water were eaten off by the shipworm, that the outer end of the wharf had settled from two to three feet, rendering it an unsafe place to land. The gale of June 15 and 16, 1893, completely wrecked it. Repairs are urgently required to the buoy shed also.

Egmont Key, entrance to Tampa Bay, Gulf of Mexico, Florida.—The outer end of the wharf is in an unsafe condition and needs rebuilding. Many of the piles are eaten off by the shipworm, the fender piles worn and broken; in easterly winds the tenders can not lie at the wharf with safety. A new cistern should be added, with pipes from both the old and new leading to the end of the wharf, for watering the tenders. Except by purchase, this is the only place where fresh water can be obtained for the boilers of the light-house tenders. The buoy and coal shed are in good condition.

Key West buoy depot and coal shed, Gulf of Mexico, Florida.—The coal shed has settled considerably. It should be raised to the level of the wharf, and have new piles driven under it for its support. The wharf needs new planking and most of the stringers and piles should be replaced. New gutters for the shed, and a new cistern with connecting pipes to the end of the wharf are required, but until the coal shed is raised to the level of the other part of the building so that the water from the roof could be utilized, there is no use for a cistern. The naval authorities kindly supply the tenders with water for culinary and drinking purposes, but object to doing so for use in the boiler. This place is in urgent need of repairs.

Pensacola, Florida.—This depot is in good condition but has no wharf. The navy wharf, although $400 was expended in repairs during the year, is still so unsafe that the Commandant will not permit the tender to use it unless she has an anchor down off the wharf with 60 fathoms of chain to haul out by. The same regulations as to fresh water apply here as at Key West. At this depot there were manufactured during the year 100 second-class and 486 third-class shackles, 100 spare pins, 105 first-class, 110 second-class, and 500 third-class keys; 174 spare bushings, 16 chain cutters, and 18 scaling hammers; 3 first-class and 2 second-class buoys had new eyes put in; 5 buoys with patent eyes had the eyes boxed; 29 buoys were bushed, and 30 were more or less extensively patched. Ten tubular lanterns used on the beacons were extensively repaired by the depot keeper.

TENDERS.

The Laurel.—This steamer was constantly employed at the regular inspection, supply, and buoy work of the district. Her crew cleaned

Seventh District.

252 buoys and painted them three coats each, changed 236 buoys, landed 40 cords of wood and 64 rations at light-stations, made 97 inspection trips, and worked 91 days at the different depots. The engineers bushed 40 and patched 10 buoys while away from the depot shop. She was under steam 313 days and fires were hauled 52 days. In doing this work she steamed about 10,717 nautical miles and consumed, for all purposes, some 605 tons of bituminous coal. A new whale-boat was received at the beginning of the year. The dingy is in good condition. The tender is in good working condition but needs some repairs. The engines and boiler are in good condition. On October 22, 1892, a new crank shaft for the starboard engine was received and put in place by November 4. The tender has had the use of both engines for the first time since June 3, 1892. On November 28, 1892, a spare crank shaft was received. On December 7, 1892, while at Mobile, Ala., the tender was docked and examined below the water-line for a leak, which was found around the main injection pipe, and stopped; 59 feet of the shoe, found missing, were replaced; the sheathing metal was replaced where needed, and all the under-water valves and connections were overhauled.

The Putnam.—This steamer was laid up at Milton, Fla., in charge of a watchman, until January 25, 1893, when she was sold at auction. Before advertising her sale the steam windlass was removed and placed in store for further service, and all articles of use in the service were transferred to the tender Laurel or the storehouse.

EIGHTH DISTRICT.

The eighth district extends from the mouth of the Perdido River, the boundary between Florida and Alabama, to the Rio Grande, the southwestern boundary of Texas, and includes all aids to navigation on the Gulf coast of the United States within these limits, together with those in Lakes Borgne, Pontchartrain, Maurepas, Grand Lake, and Lake Chicot, and those on the Mississippi River below New Orleans, La.

Inspector.—Commander Dennis W. Mullan, U. S. Navy.

Engineer.—Maj. James B. Quinn, Corps of Engineers, U. S. Army.

In this district there are—

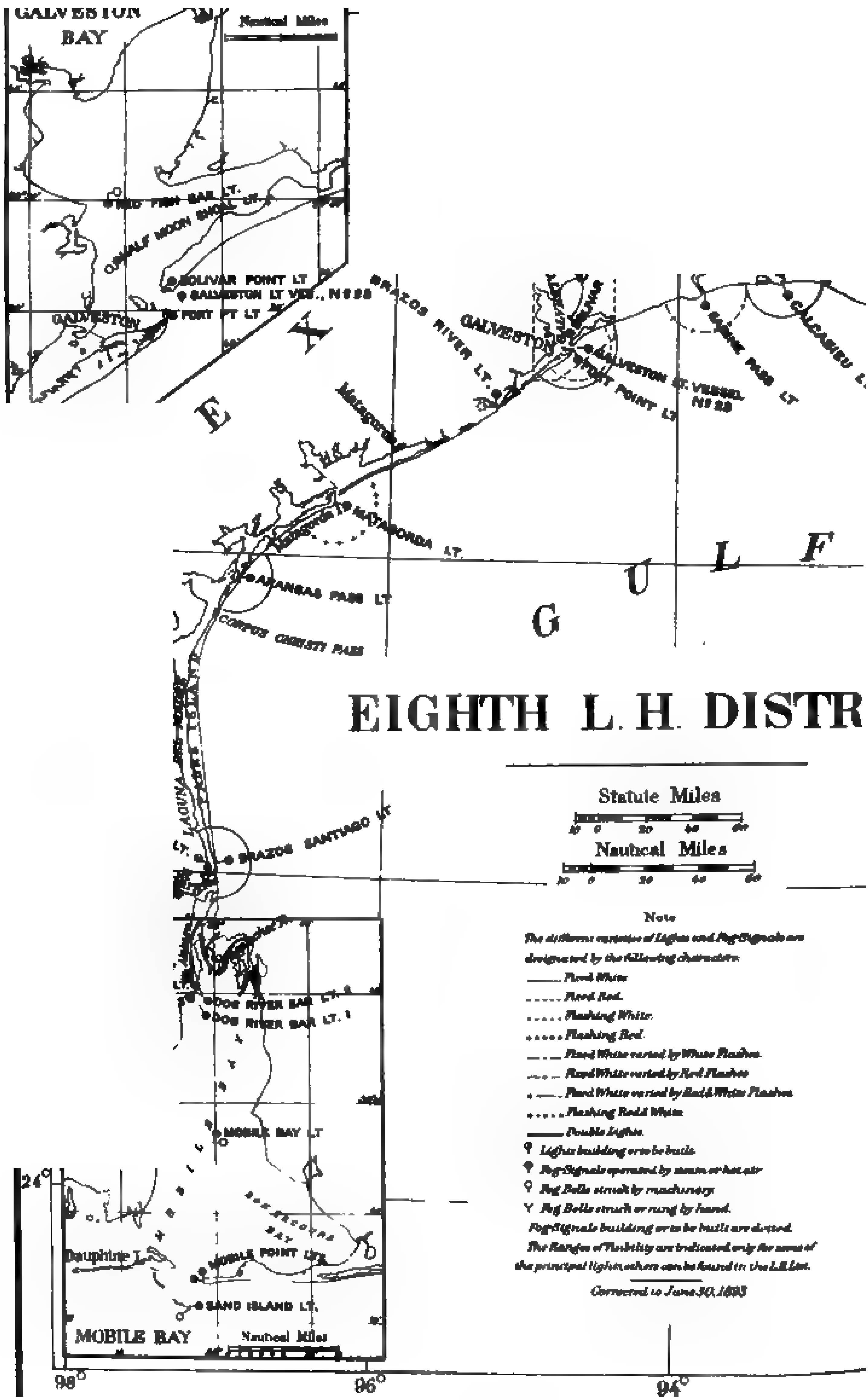
Light-houses and beacon lights (including seventeen post lights on the Mississippi River, Grand Lake, and Lake Chicot)	66
Light-ships in position	2
Day or unlighted beacons	13
Fog signal operated by steam	1
Fog signals operated by clockwork	11
Whistling buoys in position	3
Bell buoys in position	1
Other buoys in position	93
Steamer *Pansy*, buoy tender and for supply and inspection	1
Steamer *Arbutus*, for construction and repair in the Seventh and Eighth districts	1

LIGHT-HOUSES.

779. Sand Island, off Mobile Point, Gulf of Mexico, Alabama.—The keeper's dwelling was removed to a more secure location to insure its safety from the encroachment of the sea. The distance from the center of the dwelling to the center of the tower is 783 feet.

The Sand Island day beacon was erected January 15, 1893. It is pyramidal in form, 25 feet high, and stands 642 feet SSE. ½ E. from Sand Island light-house. The channel across the outer bar, at the entrance to Mobile Bay, is shifting, and it is probable that much time will not elapse before the present beacon will have to be moved. This work cost $1,000. It was not practicable to build this beacon before the end of the fiscal year.

783. Dog River Bar Beacon, No. 1, on Dog River Bar, Alabama.—This beacon, which was damaged by collision last July, was thoroughly repaired and is now in good condition.


GALVESTON
BAY
Nautical Miles
BOLIVAR POINT LT
GALVESTON
BRAZOS RIVER LT.
GALVESTON
SABINE PASS LT
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FORT POINT LT
Matagorda
MATAGORDA LT.
ARANSAS PASS LT
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Note
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Flashing White.
Flashing Red.
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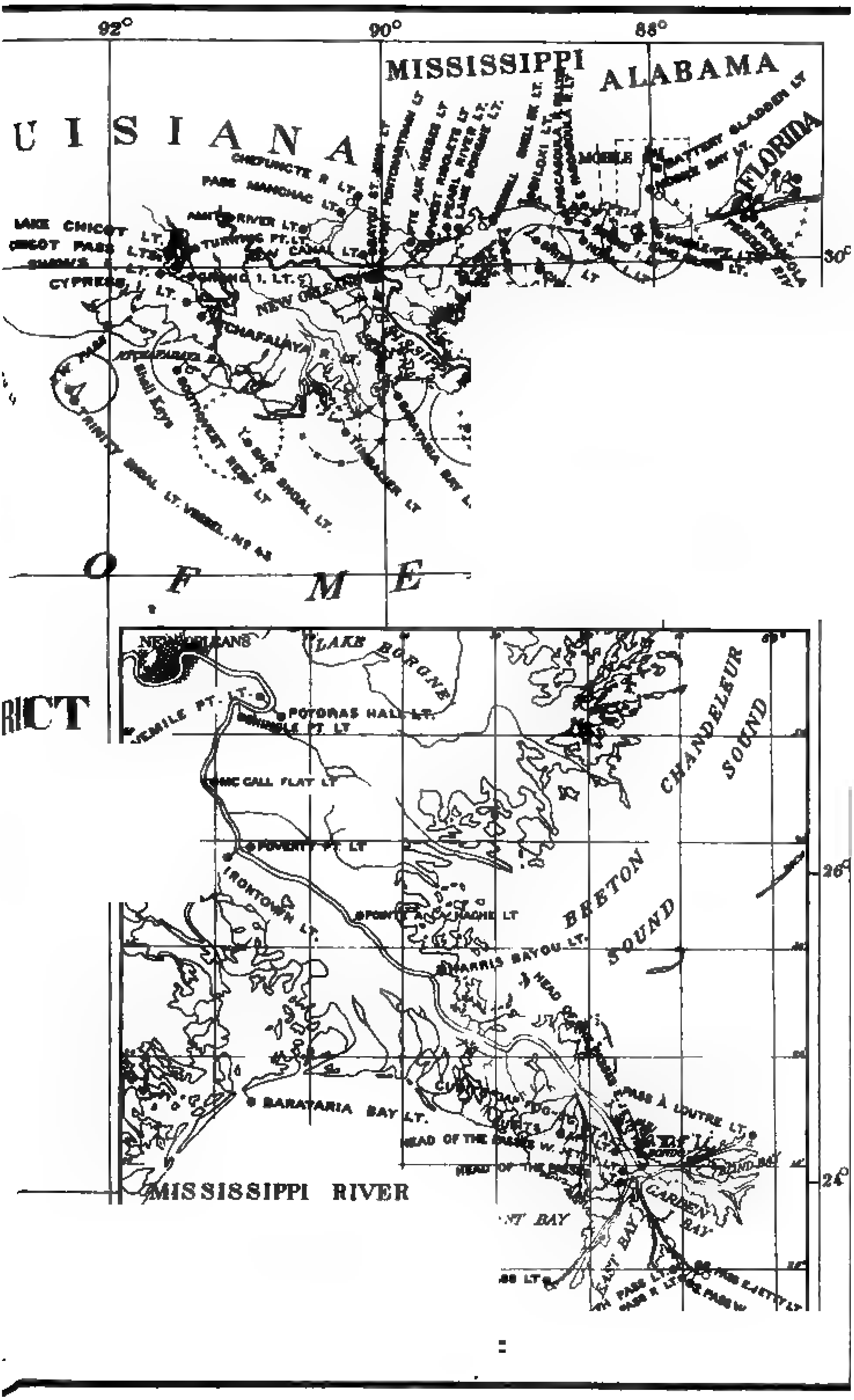
Fixed White varied by Red Flashes
Fixed White varied by Red & White Flashes.
Flashing Red & White.
Double Lights.
Lights building or to be built.
Fog-Signals operated by steam or hot air
Fog Bells struck by machinery.
Fog Bells struck or rung by hand.
Fog-Signals building or to be built are dotted.
BRAZOS SANTIAGO LT
MOBILE BAY LT
MOBILE POINT LT
SAND ISLAND LT.
Dauphine I.
MOBILE BAY
Nautical Miles
24°
98°
96°
94°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MISSISSIPPI
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U I S I A N A
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CHICOT PASS LT.
CYPRESS I. LT.
TURNING PT. LT.
NEW CANAL LT.
NEW ORLEANS
TCHAFALAYA
Shell Keys
TRINITY SHOAL LT. VESSEL, Nº 43
SOUTHWEST REEF LT.
SHIP SHOAL LT.
TIMBALIER LT.
MOBILE
O F M E
RICT
NEW ORLEANS
LAKE BORGNE
POYDRAS HALL LT.
CHANDELEUR
SOUND
BRETON
SOUND
POVERTY PT. LT.
IRONTOWN LT.
HARRIS BAYOU LT.
BARATARIA BAY LT.
PASS À LOUTRE LT.
HEAD OF THE PASSES
GARDEN BAY
EAST BAY
MISSISSIPPI RIVER

Eighth District.

—. *The Ship Channel, Mobile Bay, Alabama.*—The establishment of light-stations here, at a cost not exceeding $60,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

787. *Horn Island, eastern end of Horn Island, Gulf of Mexico, Mississippi.*—A topographical survey of this reservation was made during the year.

788. *Round Island, off Pascagoula, Gulf of Mexico, Mississippi.*—A topographical survey of the reservatian was made.

790. *Pascagoula River (rear), at the entrance to the Pascagoula River, Mississippi.*—This beacon which was damaged by lightning on July 18, 1892, was thoroughly repaired and is now in good condition.

791. *East Pascagoula River, mouth of East Pascagoula River, Mississippi.*—A topographical survey was made at this station.

792. *Ship Island, near the west end of Ship Island, Mississippi.*—A topographical survey was made at this station.

793. *Biloxi, western entrance to Biloxi Bay, Mississippi.*—A topographical survey of this reservation was made.

797. *Pearl River, Mississippi Sound, Mississippi.*—Nothing has been yet heard from the United States attorney regarding the purchase of the site for this light. The structure can not be erected until the title to the site is vested in the United States.

805. *Amite River, near the mouth of Amite River, Lake Maurepas, Louisiana.*—Two additional rooms, 12 feet by 13 feet in plan, on eight foundation piles were put up at this station. A new cistern was built on four foundation piles, and various repairs were made.

813. *Head of the Passes, on Deer Island, at junction of Southwest and South passes, Mississippi River, Louisiana.*—An oil house was built at this station and various repairs were made.

814. *Head of the Passes West Jetty, upper entrance to South Pass, Mississippi River, Louisiana.*—A new structure of pyramidial form, painted black, and intended to carry a lens lantern, was erected to replace the Head of the Passes West Jetty beacon, destroyed on February 6, 1892. The new beacon bears N. by W. ¼ W. from the Head of the Passes light-house, Louisiana, distant from it 1,354 feet. It stands on the west side of the jetty. The light will be 25 feet from the water surface, at mean high water.

815. *Head of the Passes East Jetty, upper entrance to South Pass, Louisiana.*—Owing to the caving of the banks of the river this beacon was in imminent danger of being washed away. To make it secure, a more substantial foundation pile 40 feet long was put down. The light was not changed in either characteristic or position.

836. *Calcasieu, on the west bank of Calcasieu Pass, at the entrance to Calcasieu River, Louisiana.*—A new cistern measuring 9 feet by 10 feet

Eighth District.

in plan was put up. A fence was built around the station and other minor repairs were made.

—. *Mermenteau River light-station, near the mouth of the Mermenteau River, Gulf of Mexico, Louisiana.*—The establishment of a light here, at a cost not to exceed $7,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

837. *Sabine Pass, on Brant Point, entrance to Sabine River, Louisiana.*—The wharf and approaches to this station were rebuilt.

—. *Brazos River light-station near the mouth of the Brazos River, Texas.*—The Board was asked, through the regular channels for its opinion touching the merits of the then pending bill for the establishment of a light-house, fog signal, and range lights at the mouth of Brazos River, Texas. Reply was made that range lights with fog signal and a shore light were absolutely essential to the safety of the commerce entering Brazos River at night. It was estimated that a suitable shore light could be built at a cost not to exceed $40,000, and that a suitable range light with a fog signal could be built for $10,000, and it was recommended that an appropriation of $50,000 be made for this purpose. This appropriation was made in the sundry civil appropriation act approved on March 3, 1893. Since then work was commenced on plans for the structures, and measures were taken, which are not yet successful, to acquire title to the sites on which it is proposed to place these buildings.

The location of the light-house reservation is on the banks of the canal and will be 300 feet square. It will be sufficiently removed from the river to be beyond the possibility of interference with any commercial structures on the river banks, and is furthermore upon slightly elevated ground, so as to be above overflow. The light tower would be advantageously located upon the East Jetty Range, and the canal would afford a landing place for supplies. There does not appear to be a more suitable location nearer the Gulf. The place selected for the range beacon and fog bell is upon the East Jetty at the present shore line. As it is possible that in time this light will be required at the sea end of the jetty a permanent location may not be needed at the present time.

844. *Aransas Pass, on a low island, inside of Aransas Pass, Texas.*—A new wooden platform, 10 feet by 30 feet in plan, was erected and sundry repairs were made.

846. *Point Isabel, entrance to Brazos Santiago, Gulf of Mexico, Texas.*—There is an appropriation of $8,000 for reëstablishing the light at this place. The United States attorney is still engaged in securing title to the land upon which the light-house stands.

Eighth District.

REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

780. Mobile Point, Alabama.
786. Battery Gladden, Alabama.
787. Horn Island, Mississippi.
792. Ship Island, Mississippi.
794. Cat Island, Mississippi.
799. Pointe aux Herbes, Louisiana.
800. Port Pontchartrain, Louisiana.
801. Bayou St. John, Louisiana.
803. Chefuncte River, Louisiana.
804. Pass Manchac, Louisiana.
806. Chandeleur, Louisiana.
807. Pass a Loutre, Louisiana.
808. South Pass East Jetty, Louisiana.
812. Southwest Pass, Louisiana.
813. Head of the Passes, Louisiana.
817. Cubits Gap fog-signal station, Louisiana.
824. Timbalier, Louisiana.
826. Southwest Reef, Louisiana.
839. Bolivar Point, Texas.
840. Fort Point, Texas.
842. Red Fish Bar, Texas.
843. Matagorda, Texas.
845. Brazos Santiago, Texas.

LIGHT-SHIPS.

835. Trinity Shoal light-vessel, No. 43, moored 1½ miles to northward of Trinity Shoal, Gulf of Mexico, Louisiana, and about midway between its extreme ends.—This vessel was not repaired during the past year. The main rigging is old and in poor condition. It will be necessary to strip and replace it soon. The standing rigging is in fair condition. New chain for the hoisting lantern was supplied from the general depot.

838. Galveston light-vessel, No. 28, inside of Galveston Bar, Gulf of Mexico, Texas.—On the night of September 25, 1892, this vessel was found to be on fire, but it was extinguished with but small loss. The fire was caused by a defective lamp in the lantern. A new set of lamps and reflectors, and a new trysail were furnished.

DAY OR UNLIGHTED BEACONS.

The beacons are in fair condition. A new day beacon was erected on Sand Island, Alabama.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

835. Trinity Shoal light-vessel, No. 43, Gulf of Mexico, Louisiana.—This 12-inch steam whistle was in operation about fifty hours and consumed some 6 tons of coal. It has locomotive boilers.

BUOYAGE.

The buoyage of the district is in good condition. The spare buoys in the depot were also looked after and kept in good condition and ready for any emergency. A new buoy was placed at Horn Island, Mississippi, to mark the bulkhead. A bell buoy, 10 third-class nun, and 5 third-class can buoys were received and stored in the depot at Port Eads. A good supply of chain is on hand.

Eighth District.

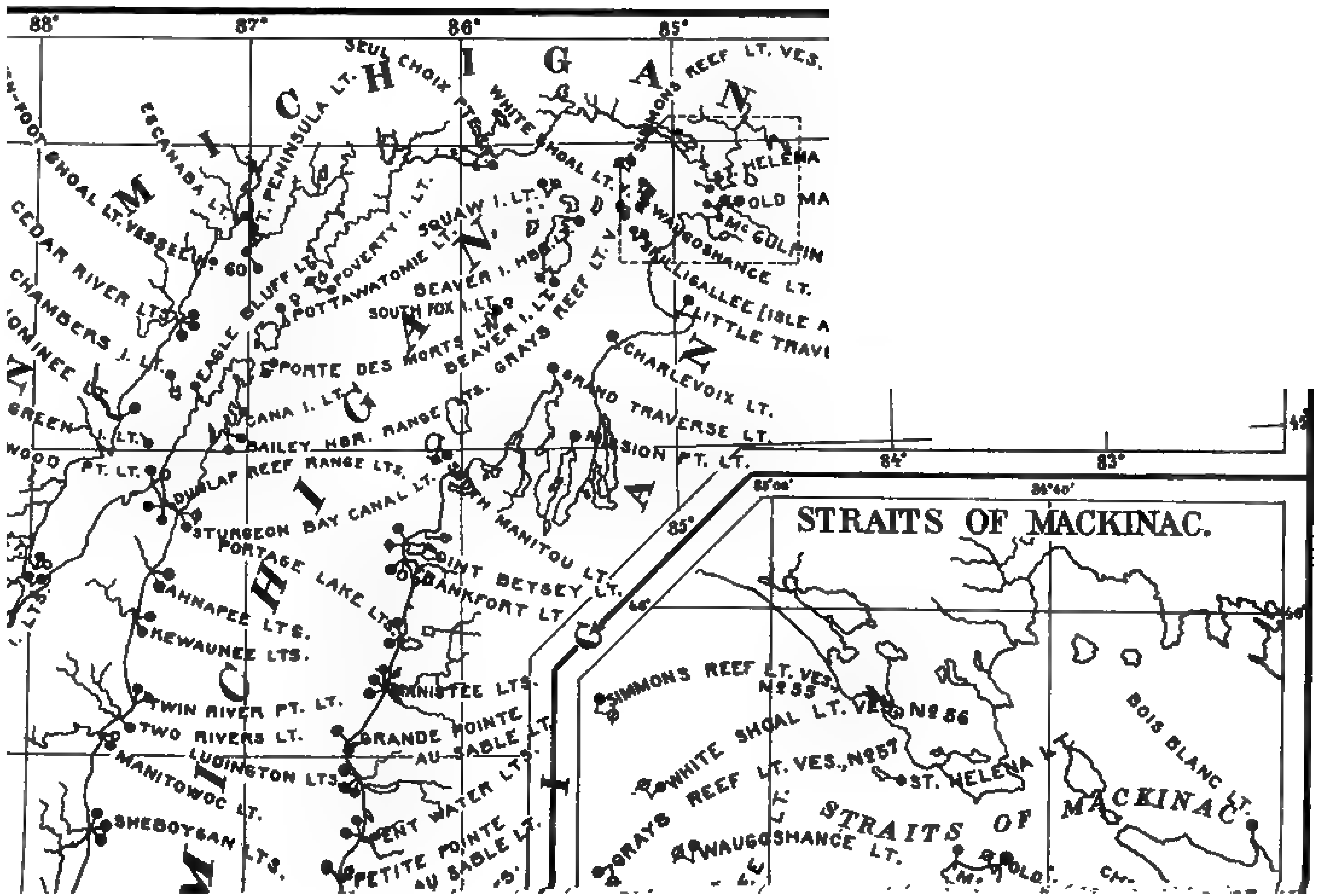
DEPOTS.

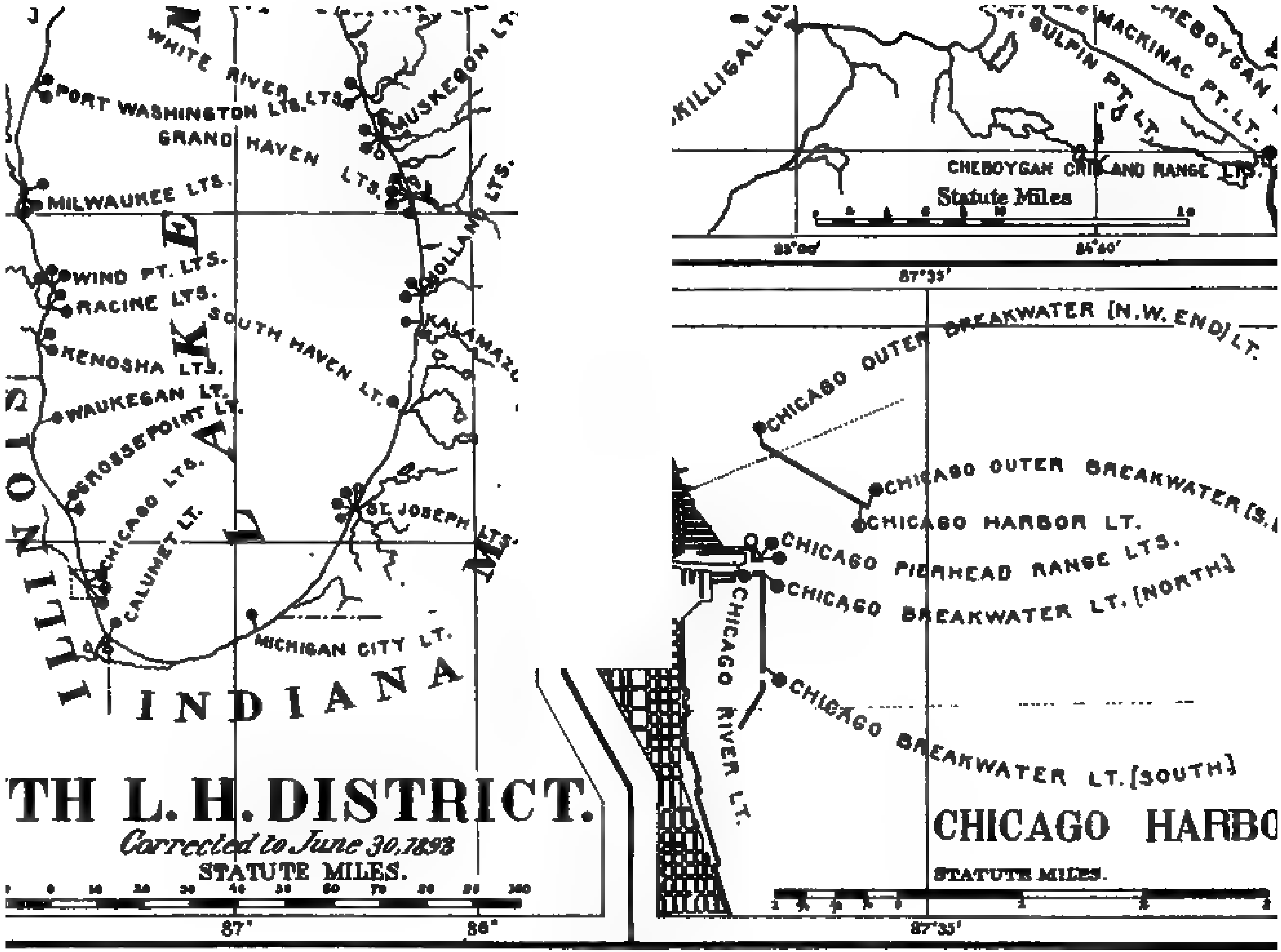
Port Eads, La.—The coal shed, buoy shed, and wharf are in good condition.

TENDERS.

The Arbutus.—This steamer was actively employed during the year in making repairs to stations in the seventh and eighth districts. During the year she was docked and the old metal taken off and replaced with new. The top sides and decks were recalked, and new garboards, limber-chain, and a new beam put in. A new boiler was put in place, steam connections made, and the main engines, circulating pumps, etc., were thoroughly overhauled and put in order. The deck and deck houses were also repaired and a new canvas roof was put on. New fore, aft, and side awnings were furnished, and two new lifeboats were also supplied. The boat was repainted, minor repairs were made, and it is now in good condition. During the year the vessel ran 10,944 miles and consumed 581 tons of coal.

The Pansy.—This steamer was employed during the year attending to the buoyage, supplying light vessels and stations with rations, fuel, and sundry supplies, erecting post lights on Mississippi River, Louisiana, and conveying the inspector on the quarterly visits of inspection to the vessels and stations in the district. The crew overhauled and painted the spare buoys in the depot. During last summer repairs were made to portions of the machinery and some nineteen pieces of new deck plank were placed. During the year she placed 1 new buoy, replaced 4, recovered 1, changed 83, and cleaned and painted 120 buoys. She steamed 7,922 miles and consumed about 481 tons of coal.


STRAITS OF MACKINAC.
88°
87°
86°
85°
84°
83°
SEUL CHOIX PTE. LT.
WHITE SHOAL LT.
SIMMONS REEF LT. VES.
ST. HELENA
OLD MACKINAC
McGULPIN
WAUGOSHANCE LT.
SKILLIGALLEE (ISLE AUX GALETS)
LITTLE TRAVERSE
CHARLEVOIX LT.
GRAND TRAVERSE LT.
MISSION PT. LT.
PENINSULA LT.
ESCANABA LT.
SHOAL LT. VESSEL No. 60
CEDAR RIVER LTS.
CHAMBERS I. LT.
GREEN I. LT.
EAGLE BLUFF LT.
POVERTY I. LT.
POTTAWATOMIE LT.
SQUAW I. LT.
BEAVER I. HBR. LT.
SOUTH FOX I. LT.
BEAVER I. LT.
GRAYS REEF LT. V.
PORTE DES MORTS LTS.
CANA I. LT.
BAILEY HBR. RANGE LTS.
DUNLAP REEF RANGE LTS.
STURGEON BAY CANAL LT.
PORTAGE LAKE LTS.
MANITOU LT.
POINT BETSEY LT.
FRANKFORT LT.
AHNAPEE LTS.
KEWAUNEE LTS.
MANISTEE LTS.
TWIN RIVER PT. LT.
TWO RIVERS LT.
GRANDE POINTE AU SABLE LT.
LUDINGTON LTS.
MANITOWOC LT.
WHITE WATER LTS.
SHEBOYGAN LTS.
PETITE POINTE AU SABLE LT.
SIMMONS REEF LT. VES. No. 55
WHITE SHOAL LT. VES. No. 56
REEF LT. VES. No. 57
ST. HELENA LT.
BOIS BLANC LT.
STRAITS OF MACKINAC
GRAYS
WAUGOSHANCE LT.
OLD


WHITE RIVER LTS.
PORT WASHINGTON LTS.
GRAND HAVEN LTS.
MUSKEGON LT.
MILWAUKEE LTS.
HOLLAND LTS.
WIND PT. LTS.
RACINE LTS.
SOUTH HAVEN LT.
KALAMAZOO
KENOSHA LTS.
WAUKEGAN LT.
GROSSEPOINT LT.
CHICAGO LTS.
CALUMET LT.
ST. JOSEPH LTS.
MICHIGAN CITY LT.
ILLINOIS
INDIANA
TH L. H. DISTRICT.
Corrected to June 30, 1893
STATUTE MILES.
87°
86°
KILLIGALLEE
MACKINAC PT. LT.
CHEBOYGAN
SULPIN PT. LT.
CHEBOYGAN CRIB AND RANGE LTS.
Statute Miles
87°33'
CHICAGO OUTER BREAKWATER (N.W. END) LT.
CHICAGO OUTER BREAKWATER (S.
CHICAGO HARBOR LT.
CHICAGO PIERHEAD RANGE LTS.
CHICAGO BREAKWATER LT. (NORTH)
CHICAGO RIVER LT.
CHICAGO BREAKWATER LT. (SOUTH)
CHICAGO HARBO
STATUTE MILES.
87°33'

NINTH DISTRICT.

The ninth district includes all aids to navigation on Lake Michigan, Green Bay, and tributary waters, and the Straits of Mackinac, west of a line drawn across the straits from Old Mackinac Point.

Inspector.—Commander Nicoll Ludlow, U. S. Navy, to December 15, 1892; Commander John J. Brice, U. S. Navy, from December 15, 1892.

Engineer.—Col. Orlando M. Poe, Corps of Engineers, brevet brigadier-general U. S. Army, to December 14, 1892; Maj. Milton B. Adams, Corps of Engineers, U. S. Army, from December 14, 1892.

There are in this district—

Light-houses and beacon lights	95
Light-ships in position	3
Fog signals operated by steam	19
Fog signals operated by clockwork	7
Electric-lighted buoys	13
Other buoys in position	85
Steamer *Dahlia*, buoy tender and for supply and inspection	1
Steamer *Amaranth*, engineer's tender, for repairs and construction	1
Steamer *Warrington*, engineer's tender, for repairs and construction	1
Steamer launch *Lotus*, for construction and repair	1

All the light-stations, fog signals, and light-vessels in the district are in good order except Seul Choix Pointe. The keepers are thoroughly interested in their work and careful of the public property under their charge; they are sober and industrious and deserve commendation for their vigilance and faithfulness.

LIGHT-HOUSES.

1255. Old Mackinac Point, Straits of Mackinac, Michigan.—The construction of the light-house and keeper's dwelling under contract was completed on October 27, and the station was lighted for the first time on the night of October 25, 1892. The grounds surrounding the light-house buildings were filled and graded and inclosed by a picket fence.

Slight repairs were made by the keeper to the fog-signal boilers and steam whistle.

The following recommendation, which was made in the Board's last annual report, is renewed:

The fog-signal house is too near the dwelling and should be moved 50 feet. The established grade will require the raising of the signal house to conform to the grounds about the dwelling. It is desirable that the signal house should be moved to a safe and convenient distance from the dwelling, and space given for storage and fuel. It is therefore recommended that the lots on the east side of the light-house property be acquired. It is estimated that this can be done for not exceeding $1,000, and it is recommended that an appropriation of this amount be made therefor.

Ninth District.

The additional ground needed is 100 feet wide, with frontage of 129 feet on the street 170 feet long on the west side, and 89 feet on the east side.

1261. Waugoshance, Lake Michigan, Michigan.—A working party put a new asphaltic slag roof on the dwelling and painted the tower and dwelling in alternate horizontal bands of red and white.

1267. South Fox Island, Lake Michigan, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *North Manitou Island, Lake Michigan, Michigan.*—The establishment of a light and fog signal here, at a cost not to exceed $20,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1270. South Manitou, Lake Michigan, Michigan.—A circular iron oil house was erected 100 feet northeast of the tower.

1272. Frankfort Pierhead, Lake Michigan, Michigan.—A small wooden structure, measuring 10 feet by 16 feet in plan, was erected for use as a watchroom on the south pier. The act approved August 5, 1892, appropriated $1,000 for the establishment here of a fog bell. On April 14, 1893, the work was commenced, and on June 15 it was completed and the signal put in operation. The boathouse, which one of the Toledo, Ann Harbor and Northern railway boats ran into, was rebuilt and received a new hoisting crane.

1273, 1274. Portage Lake Pierhead Range, Lake Michigan, Michigan.—The following recommendation, which was made in the Board's last two annual reports, is renewed:

Portage Lake occupies a position in the dangerous bight between Point Betsey and Big Point Sable, and for several years has been under improvement by the United States as a harbor of refuge for the general commerce of the lake. The width of entrance, 380 feet, is exceeded by but one of the harbors, Grand Haven, on the east shore of the lake, and while the works still lack much of their projected development and the entrance depth is as yet by no means what it is designed to secure, the completion of the harbor will furnish a valuable shelter in case of need, and it has been shown that in its present condition the harbor would be of service if it were so marked by lights as to permit its use after dark. Plans and specifications were made, therefore, for the establishment of a gasoline pierhead fixed red light of the fifth order and a fixed red tubular lantern pierhead range light at this place. Construction was begun on March 16 and completed early in May. The lights were exhibited for the first time on the night of April 30, 1891. The lights stand near the outer end of the north pier, this being the only portion of either pier that would support them. The best water is now near the north pier, but it is probable that when the construction is completed the channel will occupy a more nearly central position, and inasmuch as the harbors on the east coast are in general lighted on the south side the Portage Lake lights should be placed on the south pier for the sake of uniformity. The focal plane of the main light is 40 feet above the level of the lake, and it can be

Ninth District.

seen from 2 to 3 miles in clear weather. The structure is a square wooden tower painted white, surmounted by a black iron lantern, with a brown parapet. The lower part of the tower is open framework, but the upper part is inclosed for a watchroom. A dwelling for the keeper should be erected on the south shore, as there are but few houses in the vicinity which could be used as quarters. The estimated cost of the building proposed is $3,500, and it is recommended than an appropriation of that amount be made for this purpose.

1277. Grande Pointe au Sable, Lake Michigan, Michigan.—This station was thoroughly repaired. A circular iron oil house of 360 gallons' capacity was erected 106 feet south of the tower.

1280. Ludington Pierhead, Lake Michigan, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, and the establishment of a dwelling for a keeper at a cost not to exceed $4,500, were authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amounts named be appropriated.

1283. Petite Pointe au Sable, Lake Michigan, Michigan.—A circular iron oil house of 360 gallons' capacity was built 100 feet northeast of the tower. Various minor repairs were made.

1285. White River, Lake Michigan, Michigan.—The characteristic of the light was changed on December 12, 1892, from a fixed white light, varied by a red flash every minute, to a fixed white light, varied by a red flash every forty seconds. An additional flash panel was fitted to the lens and the revolving apparatus adjusted accordingly.

1286. Muskegon Pierhead front range, Lake Michigan, Michigan.—The schooner *Ralph Campbell*, on entering this harbor during a gale on October 28, ran into and broke the middle post supporting the wires on which the tubular lantern runs, and 14 posts and the hand railing of the elevated walk. The necessary repairs were made.

1291. Grand Haven, Lake Michigan, Michigan.—The characteristic of the light was changed from a fixed white light varied by a white flash every ninety seconds to a fixed white light varied by a white flash every minute. This was done on December 10, 1892. An additional flash panel was fitted to the lens and the revolving apparatus was properly adjusted.

1294. Kalamazoo, Lake Michigan, Michigan.—This light was discontinued as a pier light and reëstablished as a lake-coast light on August 16, 1892. The illuminating apparatus was transferred to the main light-house.

1297. St. Joseph Pierhead, Lake Michigan, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,000, was authorized by the act of February 15, 1893, but no appropriation has yet been made. The Board recommends that the amount named be appropriated.

1298. St. Joseph, Lake Michigan, Michigan.—The characteristic of this light was changed on December 8, 1892, from a fixed white light varied

Ninth District.

by a white flash every ninety seconds to a fixed white light varied by a white flash every forty-five seconds. An additional flash panel was fitted to the lens and the revolving apparatus was properly adjusted.

1305. Chicago River, Lake Michigan, Illinois.—The keeper's dwelling was connected with the city water mains.

1306. Chicago Harbor, Lake Michigan, Illinois.—The construction of the stone foundation pier under contract was completed on September 2, 1892. The metalwork for the tower, which was delivered in Chicago, was purchased to be held until additional appropriation for carrying on the work was made by Congress. The act of March 3, 1893, appropriated $15,500 for completing the construction of this station. The erection of the metalwork was commenced in March and at the end of June the base course, with the first and second story staves and vestibule, were in place and the brick lining of the basement was completed. The pier was protected by placing 694 cords of riprap stone on the southeast, southwest, and northwest sides, filling to within 10 feet of the water level at the face of the pier, and gradually sloping off to a distance of 40 feet base, with a berm of about 10 feet. Factory work and finishing lumber were bought for the tower. Materials were purchased for the construction of two fog-signal houses on the pier, and were transported to the site by the *Amaranth*. The signals will be erected at an early date. The other construction will be done by day's work. The station may be in complete working order in the early fall.

1308. Chicago Outer Breakwater, northwest end, Lake Michigan, Illinois.—This light was moved to the Emergency Intake Waterworks Crib on October 19, 1892.

1310. Waukegan, Lake Michigan, Illinois.—The light-house site was inclosed with a picket fence. A surveyor determined the proper boundary lines.

1311. Kenosha, Lake Michigan, Wisconsin.—The characteristic of the light was changed on December 6, 1892, from a fixed white light varied by a white flash every ninety seconds, to a fixed white light varied by a white flash every forty-five seconds, an additional flash panel being fitted to the lens.

1313. Racine, Lake Michigan, Wisconsin.—This station was connected with the city water mains to obtain an adequate supply of pure water for domestic uses.

—. South Milwaukee, Lake Michigan, Wisconsin.—Recommendation was made through the proper channel to Congress in February, 1893, for the establishment of a light at this place. South Milwaukee is a village about 10 miles south of the city of Milwaukee; it is a thriving manufacturing place of some 1,200 inhabitants. There is a large business done here in building materials. It is claimed that it will double its population within a year. The Board is of the opinion that a light should

Ninth District.

be established on the north pier at the harbor, and it is estimated that it will cost as follows:

Tower (skeleton light closed at the top 36 feet to level of focal plane)	$1,500
Fourth-order lantern	700
Fourth-order lens and lamp	700
Elevated walk, 600 feet long, at $1.50 per foot	900
Lot for dwelling	500
Keeper's dwelling	2,500
	6,800
Contingencies	680
Total	7,480

A site for the dwelling must also be obtained, but it would be at small cost. The Board therefore recommended, and that recommendation is now renewed, that an appropriation of $7,500 be made for the purpose.

1317. Milwaukee, Lake Michigan, Wisconsin.—The characteristic of this light was changed on December 4, 1892, from a fixed white light varied by a white flash every two minutes to a fixed white light varied by a white flash every forty-five seconds. An additional flash panel was fitted to the lens and the revolving apparatus properly adjusted.

1320, 1321. Sheboygan Pierhead Range, Lake Michigan, Wisconsin.—The establishment of a fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1323. Manitowoc Pierhead, Lake Michigan, Wisconsin.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1325. Twin River Point, Lake Michigan, Wisconsin.—A circular iron oil house was erected at this station 105 feet southwest of the tower. The materials were landed by the light-house tender *Amaranth*. The work was done under the direction of the keeper.

1327. Kewaunee Pierhead (rear), Lake Michigan, Wisconsin.—The establishment of a steam fog signal at the entrance to this place was recommended to Congress by the Board through the proper channels in February, 1893. The northern terminus of the Toledo, Ann Arbor and Northern Railroad is at Frankfort, Mich., and their large transfer boats ply between there and Kewaunee, Wis., daily, carrying their cars across Lake Michigan, a distance of 65 miles, and connecting at Kewaunee with the Kewaunee and Green Bay Railroad for St. Paul and the Northwest. The Goodrich Transportation Co's. steamers also make this a regular stopping place. Their boats run summer and winter and have to contend with fogs and snowstorms. Kewaunee is a good harbor,

Ninth District.

and is much used by the smaller class of lake carriers. One of the transfer steamers went ashore last fall in trying to make the harbor in thick weather, thereby causing much delay to travel on this new and important route, and narrowly escaping loss with the attendant destruction of life and property. The Board therefore recommended the establishment of a fog signal at its entrance, at an estimated cost of $5,500. That recommendation is now renewed.

1328, 1329. Ahnapee Pierhead Range Lights, Lake Michigan, Wisconsin.—A bridge was built to connect the detached cribs upon which the lights are shown with the shore cribs. The framing of the woodwork was done at Manitowoc and from there shipped to Ahnapee. A portion of the stone filling of the piers was removed, and a timber 12 inches square was bolted to the cross-ties for a foundation upon which to erect the bridge bents. The bridge is raised 10 feet above the piers, and is approached by stairs at each end. The illuminating apparatus for these ranges was set in position on December 23, and tested, and the station was left in readiness for lighting. The lights were exhibited for the first time March 1, 1893.

1330. Sturgeon Bay Canal Pierhead, Wisconsin.—The establishment of a new coast light on shore near to the keeper's dwelling, at a cost not to exceed $20,000, was authorized by the act approved February 15, 1893, but no appropriation has yet been made therefor. The Board recommends that the amount named be appropriated.

1334. Porte des Morts, Lake Michigan, Wisconsin.—A circular iron oil house was erected 82 feet southeast of the tower.

—. *Portes des Morts Ranges, Lake Michigan, Wisconsin.*—The establishment of range lights and a fog signal on the southwest side of Plum Island in the Porte des Morts Passage, at a cost not to exceed $21,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Little Gull Island, St. Martin Passage, entrance to Green Bay, Lake Michigan, Michigan.*—The establishment of a light and fog signal here, at a cost not to exceed $20,000 was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *St. Martin Island, St. Martin Passage, between St. Martin and Little Gull Islands, entrance into Green Bay, Lake Michigan, Michigan.*—The establishment of a fourth-order light and a fog signal here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Manistique, Lake Michigan, Michigan.*—The establishment of a coast light and fog signal here, at a cost not to exceed $32,000, was authorized by the act approved February 15, 1893, but no appropria-

tion therefor has yet been made. The Board recommends that the amount named be appropriated.

1337. Seul Choix Pointe, Lake Michigan, Michigan.—Last year an appropriation of $3,500 was asked to complete the structures at this station. Since the estimate was made the conditions have somewhat changed. There has been deterioration in the unfinished work, and the eight-hour law has made a difference in the cost of labor. It is now estimated that $5,000 is needed to complete the structures. It is recommended that the $5,000 appropriated for moving St. Marys River upper range lights, Michigan, and which it is stated under that head, is no longer needed for that purpose, be made available for completing these structures.

By the act approved February 15, 1893, a fog signal was authorized for this station, at a cost not to exceed $5,500, but no appropriation was made. By the act approved March 3, 1893, an appropriation of $3,300 was made to complete the fog signal at this point, but as no money had been previously appropriated for this purpose the fog signal had not been begun, and the appropriation for completion was, therefore, not available. The total cost of establishing this fog signal is estimated at $5,500, and it is recommended that an appropriation of $2,200 be made to begin this work, for the completion of which $3,300 has already been appropriated.

1338. Squaw Island, Lake Michigan, Michigan.—The work on the construction of the light-house and fog signal, with attached buildings, was continued during the season by day's labor, and was finally completed on September 16, 1892. The site at the north end of the island and portions at the south end were cleared of brush and trees to allow the light to be seen from all directions. The station was put in operation for the first time on October 10, 1892.

1340. Escanaba, on Sand Point, Green Bay, Michigan.—The following recommendation, which was made in the Board's last three annual reports, is renewed:

A steam signal here is not essential, as the navigation of Little Bay de Noquette is quite unobstructed, and with a steam whistle on Eleven-Foot Shoal a vessel should be able to reach the point with reasonable safety. A fog bell struck by machinery in the light-station at Escanaba, on Sand Point, would be a valuable addition to the service of this station. It can be set up for about $1,100. It is recommended that an appropriation of this amount be made therefor.

—. *Gladstone, Little Bay de Noquette, an extension of Green Bay, Michigan.*—The establishment of a light on Sanders Point, or Squaw Point, to guide into Gladstone Harbor, at a cost not to exceed $10,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1344. Eagle Bluff, Green Bay, Wisconsin.—A barn was built 16 by 24 feet in plan, and one and a half stories high.

Ninth District.

1345. Chambers Island, Green Bay, Lake Michigan, Wisconsin.—The landing wharf and the boat ways were repaired. A new barn was built and minor repairs were made.

1347. Green Island, Green Bay, Lake Michigan, Wisconsin.—The well was deepened to a depth of 20 feet. Two additional landing cribs, 30 feet long and 9 feet wide, were placed in position, filled with stone, and decked over. The old boat ways were removed and new ones were placed.

—. Peshtigo Shoal, Green Bay, Lake Michigan, Wisconsin.—The establishment of a light and fog signal here, at a cost not to exceed $10,000, was authorized by the act approved February 15, 1893, but no appropriation has yet been made therefor. The Board recommends that the amount named be appropriated.

—. Menasha, Green Bay, Wisconsin.—The following recommendation, which was made in the Board's last three annual reports, is renewed:

It is now difficult to make the Menasha River at night, on account of the cut through the rock and the earth cut, which is found to be quite intricate. To meet this difficulty it is proposed to establish here two range lights, one to be placed on the site of the old Menasha light, which was discontinued under the operations of the act of March 3, 1859, which site is still Government property; the other to be placed on the northeast end of Doty Island, adjacent to the channel, which was dredged out in 1887.

It is estimated that these range lights can be established for a sum not to exceed $500, and it is recommended that an appropriation of this amount be made therefor.

REPAIRS.

During the fiscal year repairs, more or less extensive, were made at each of the following named stations:

1256. McGulpin Point, Mich.
1257. St. Helena, Mich.
1262. Skilligallee, Mich.
1264. Beaver Island, Mich.
1265. Little Traverse, Mich.
1267. South Fox Island, Mich.
1268. Grand Traverse, Mich.
1269. Mission Point, Mich.
1270. South Manitou, Mich.
1271. Point Betsey, Mich.
1276. Manistee Pierhead, Mich.
1279. Ludington Pierhead, front, Mich.
1283. Petite Pointe au Sable, Mich.
1285. White River, Mich.
1288. Muskegon, Mich.
1290. Grand Haven Pierhead, Mich.
1291. Grand Haven, Mich.
1294. Kalamazoo, Mich.
1295. South Haven Pierhead, Mich.
1300. Calumet Pierhead, Ill.
1304. Chicago Pierhead, Ill.
1305. Chicago River, Ill.
1309. Grossepoint, Ill.
1310. Waukegan, Ill.
1311. Kenosha, Wis.
1313. Racine, Wis.
1315. Wind Point, Wis.
1316. Milwaukee Pierhead, Wis.
1318. Port Washington Pierhead, Wis.
1319. Port Washington, Wis.
1321. Sheboygan Pierhead, Wis.
1322. Sheboygan, Wis.
1323. Manitowoc Pierhead, Wis.
1325. Twin River Point, Wis.
1326. Kewaunee Pierhead, front, Wis.
1327. Kewaunee Pierhead, rear, Wis.
1330. Sturgeon Bay Canal Pierhead, Wis
1334. Porte des Morts, Wis.
1344. Eagle Bluff, Wis.
1345. Chambers Island, Wis.
1347. Green Island, Wis.
1348. Sherwood Point, Wis.
1351. Tail Point, Wis.

Ninth District.

OIL HOUSES.

Oil houses were erected at the following stations: South Manitou, Grande Pointe au Sable, Petite Point au Sable, Port Washington, Twin River Point, and Porte des Morts.

LIGHT-SHIPS.

1258. *Simmons Reef light-vessel, No. 55, Straits of Mackinac, Lake Michigan, Michigan.*—This vessel left her station on December 7, 1892, and went to Cheboygan, Mich., where she wintered. She left Cheboygan on April 23, 1893, and picked up her moorings on her station at 3:30 p. m. on the same day. She is in good condition. She received during the year various articles of supply, including a fog bell.

1259. *White Shoal light-vessel, No. 56, Straits of Mackinac, Lake Michigan, Michigan.*—This vessel left her station on December 7, 1892, and arrived at Cheboygan, Mich., the day following, where she wintered. She left Cheboygan on April 23, 1893, and picked up her moorings at her station on the same day. She is in good condition. She received during the year numerous articles of supply besides a fog bell.

1260. *Grays Reef light-vessel, No. 57, Straits of Mackinac, Lake Michigan, Michigan.*—This vessel left her station on December 7, 1892, and arrived the same day at Cheboygan, where she wintered. Her stern bearing was repaired. She returned to her station on April 23, 1893. She is in good condition. She received during the year a fog bell and many other articles of supply.

—. *Eleven-Foot Shoal light-vessel, No. 60, about midway between Eleven-Foot Shoal and Corona Shoal, and about one and one-half miles from each, in Green Bay, Lake Michigan, Michigan.*—By the sundry civil appropriation act, approved August 5, 1892, it was provided that—

> The appropriation of $60,000 heretofore made in the act approved August 30, 1890, for establishing a light-station on or near Eleven-Foot Shoal, off Point Peninsula, Michigan, be applied, under the direction of the Light-House Board, for the construction or purchase and equipment of one or more light-ships for service on the Great Lakes, and that said appropriation be immediately available for such ships.

The Board arranged to build three light-vessels from this appropriation and assigned one to Corona Shoal. Contract was made for building this light-vessel at Toledo, Ohio. It was dated March 29, 1893, and it required that the light-vessel be delivered in four calendar months from that date, which makes her due on July 29, 1893. She is to be built of wood and be 80 feet 9 inches long, have 21 feet 6 inches beam, and 9 feet 5 inches depth of hold. She is to have a 6-inch steam whistle as a fog signal, actuated by a Warrington water-tube boiler able to get up steam sufficient to commence signaling in fifteen minutes from the time its fire is lighted. The characteristic of her fog

Ninth District.

signal is to be a blast of five seconds followed by a silent interval of ten seconds, repeated during the fog.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

1255. *Old Mackinac Point, Michigan.*—The 10-inch steam whistle, in duplicate, was in operation some 266 hours and consumed about 35 cords of wood.

1258. *Simmons Reef light-ship, No. 55, Michigan.*—This 6-inch steam whistle was in operation some 252 hours and consumed about 7 tons of coal and 2 cords of wood.

1259. *White Shoal light-ship, No. 56, Michigan.*—This 6-inch steam whistle was in operation some 170 hours and consumed about 9 tons of coal and nearly 2 cords of wood.

1260. *Grays Reef light-ship, No. 57, Michigan.*—This 6-inch steam whistle was in operation some 221 hours and consumed about 7 tons of coal and 1 cord of wood.

1261. *Waugoshance, Michigan.*—The 10-inch steam whistle, in duplicate, was in operation some 239 hours and consumed about 7 tons of coal and 18 cords of wood.

1262. *Skilligallee, Michigan.*—The 10-inch steam whistle, in duplicate, was in operation some 453 hours, and consumed about 7 tons of coal and nearly 14 cords of wood.

1264. *Beaver Island, Michigan.*—The first-class steam sirens, in duplicate, were in operation some 147 hours and consumed about 12 cords of wood.

1270. *South Manitou, Michigan.*—The 10-inch steam whistles, in duplicate, were in operation some 771 hours and consumed about 44 cords of wood.

1271. *Point Betsey, Michigan.*—The 10-inch steam whistle, in duplicate, was in operation some 252 hours and consumed some 24 tons of coal and about 12 cords of wood.

1276. *Manistee Pierhead, Michigan.*—The 10-inch steam whistle, in duplicate, was in operation some 446 hours and consumed some 6 tons of coal and 9 cords of wood.

1290. *Grand Haven Pierhead, Michigan.*—The first-class steam sirens, in duplicate, were in operation some 504 hours and consumed about 31 tons of coal and 1 cord of wood.

1309. *Grossepoint, Illinois.*—This 10-inch steam whistle, in duplicate, was in operation some 260 hours and consumed about 19 tons of coal and nearly 2 cords of wood.

1315. *Wind Point, Wisconsin.*—This 10-inch steam whistle, in duplicate, was in operation some 709 hours and consumed about 35 tons of coal and nearly 3 cords of wood.

1316. *Milwaukee Pierhead, Wisconsin.*—The 10-inch steam whistle, in

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duplicate, was in operation some 656 hours and consumed about 4 tons of coal and some 4 cords of wood.

1325. Twin River Point, Wisconsin.—The 10-inch steam whistle, in duplicate, was in operation some 559 hours and consumed about 3 tons of coal and 97 cords of wood.

1330. Sturgeon Bay Canal Pierhead, Wisconsin.—The 10-inch steam whistle, in duplicate, was in operation some 465 hours and consumed some 26 tons of coal and about 74 cords of wood.

1334. Porte des Morts, Wisconsin.—This first-class steam siren was in operation some 226 hours and consumed about 5 tons of coal and 14 cords of wood.

1336. Poverty Island, Wisconsin.—The 10-inch steam whistle, in duplicate, was in operation some 156 hours and consumed about 2 tons of coal and some 19 cords of wood.

1338. Squaw Island, Michigan.—The 10-inch steam whistle, in duplicate, was in operation some 130 hours since October, 1892, and consumed about 9 tons of coal.

BUOYAGE.

The buoys of the district are in good condition. They are all attended to by the tender *Dahlia*, except the Bank Point buoy in Lake Muskegon, the buoy at the entrance to St. Joseph Harbor, Michigan, those in Green Bay south of Long Tail Point, and the channel buoys in Fox River between Green Bay City and De Pere, Wis. Two spars were placed on shoal spots inside and outside Fox Island Shoals, Lake Michigan. A line of thirteen electric buoys was placed between Chicago Breakwater light-house and the World's Fair Casino wharf. These electric buoys are in mid-channel, and mark a fairway for the steamboats running between Chicago and the Exposition. By keeping to the right in going to and coming from the Fair there is little chance of collision. When these buoys were first established the steamboat people were inclined to ignore them, but they soon recognized their merit and took advantage of them. Besides their usefulness they are an important feature of the Fair. The following additions were also made to the buoyage of the water front of Chicago: A second-class can and spar on Oakland Shoal; a spar on Morgans Reef (inside); a spar on Morgans Reef; a spar to mark an obstruction or wreck in the harbor; and the buoying of anchorages for vessels attending the World's Fair.

DEPOTS.

St. Joseph, Michigan.—The supply and buoy depot at St. Joseph, Mich., has been occupied since January, 1893, but it is not yet fully completed. The supplies were delivered there, from the general depot, and taken on board the tender *Dahlia*, for delivery to the light-stations,

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fog signals, and light-vessels. The construction of the storehouse, keeper's dwelling, and carpenter and lampist shops, was continued under contract and the work was completed on January 7, 1893. A hoisting elevator of 3,000 pounds' capacity was placed in the storehouse. The grading, soiling, and fencing of the depot grounds was practically completed. Materials and cars for the tramway were delivered and will soon be placed. Steps were taken to have the station connected with the city water mains. Various minor repairs were made. The depot was in readiness for the reception of supplies in the early spring.

Supply and buoy depot for the Ninth and Eleventh light-house districts, at Scammons Harbor, southern part of Lake Huron, Michigan.—The following recommendation, made in the Board's last annual report, is renewed:

There are now in service in the ninth district 15 steam fog signals, and in the eleventh district 20, a total of 35. Provision has been made by appropriation for the construction of several more in each district, the greater number of which will be erected during the coming year; and in addition there are recommendations, applications, and pending legislation, for a number, say a dozen more, for the most of which it is probable appropriation will be made in the near future. Owing to the intricacies of navigation the prevalence of fogs, and the somewhat frequent snow squalls and storms, not less than 24 or 25 of the steam signals to be operated will be concentrated about the northern portions of Lakes Huron and Michigan, counting from Thunder Bay Island in Lake Huron, through the Straits of Mackinac, to Point Betsey in Lake Michigan, and including the stations guarding the entrances into Green Bay.

The work of supplying the existing stations with coal is already arduous, and tasks the time of the buoy tenders, which might be employed to much greater advantage in other work. With the rapid increase in the number of the signals, it seems desirable that some better provision be made for the delivery of the fuel than its transportation from Detroit and Chicago by the single tender employed in each district. The average consumption of coal at each fog-signal station is 18 tons, so that for the 35 indicated stations near the northern ends of the two lakes there will be needed some 630 tons per annum. If some 200 tons additional be allowed for the use of the two tenders in the same region, the total amount required will be, say, 830 tons.

The buoyage of the two districts is also steadily increasing with the greater number, draft, and tonnage of the lake shipping. Not only are there more buoys needed, but larger ones, as special difficulties are from time to time discovered and the need is discovered of greater visibility and better warning to vessels. It is quite evident, therefore, that the buoy tenders will be more taxed each year to give proper attention to the placing and relief of the buoys, many of which are now looked after by contractors in each district, to maintain the necessary frequency and thoroughness of inspections, and to keep the numerous light-stations supplied with their regular stores, all within the seven or eight months of navigation during which the work must be performed.

In the localities above indicated there are numerous points which, lying in or near the track of vessels, are dangerous to navigation by reason of not being sufficiently marked by buoys.

To provide for the convenient and economical coaling of the fog-signal stations in the two districts, it will be advantageous to establish a depot at a suitable place in

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the vicinity of the Straits of Mackinac and Scammons Harbor, now owned by the Light-House Establishment, suggests itself as a place in every way desirable for the purpose. The shelter is perfect, the access is easy, and the location is sufficiently central and of ample size. It will be necessary to construct a suitable wharf, coal shed, quarters for station-keeper, and other adjuncts for coaling service. In addition there should be two scows for the service of the depot, the employment of which would, in general, be as follows:

To coal the steam fog signals the scows would be loaded to a draft of say 3 feet and be towed from the depot to the stations. In ordinary cases the scow could go alongside, and the coal be handled ashore directly and without loss of time, instead of being loaded as now into a boat from a light-house tender lying off at a distance, from which several trips must be made with oars to complete the work.

A preliminary estimate of the cost of the plant recommended is as follows:

For the wharf and buoy shed	$7,500
For quarters, etc	3,000
For two scows	4,000
Contingencies	500
Total	15,000

With the multiplication of the aids to navigation in the vicinity of the Straits of Mackinac, the economy of using in certain localities light-ships of moderate dimensions and small cost in lieu of permanent light-stations, it is evident that the construction of the coaling and buoy depot for the common use of both the ninth and eleventh districts will be of great value to the Light-House Service. It is estimated that this depot can be established for not exceeding $15,000, and it is recommended that an appropriation of this amount be made therefor.

TENDERS.

The Dahlia.—This steamer was employed, during the summer and fall of 1892, in delivering fuel and rations to light-vessels, and fuel to fog-signal stations, and in taking up the buoys for the winter. On completion of the latter work, she returned to Chicago, where the crew was discharged and where she wintered. On the opening of navigation in the spring, the district buoys were taken on board and placed in position, after which the tender returned to Chicago to lay the electric buoys on the World's Fair water front. During the fiscal year 1893, she steamed about 4,972 miles and consumed some 473 tons of coal. Her engines are good and the boilers new. She received some minor repairs.

The Amaranth.—This steamer was employed during the season 1892 in delivering material required for building Squaw Island light-station, oil houses and the materials for their erection at Grande Pointe au Sable, Petite Pointe au Sable, and Twin River Point light-stations, and materials for repairs at St. Helena, South Manitou, and Point Betsey light-stations; transferring the lampist to Squaw Island, and returning workmen from that station to Detroit upon its completion; in delivering materials to Old Mackinac Point, St. Helena, Beaver Island Harbor, Grand Traverse, South Manitou, Grande Pointe au Sable,

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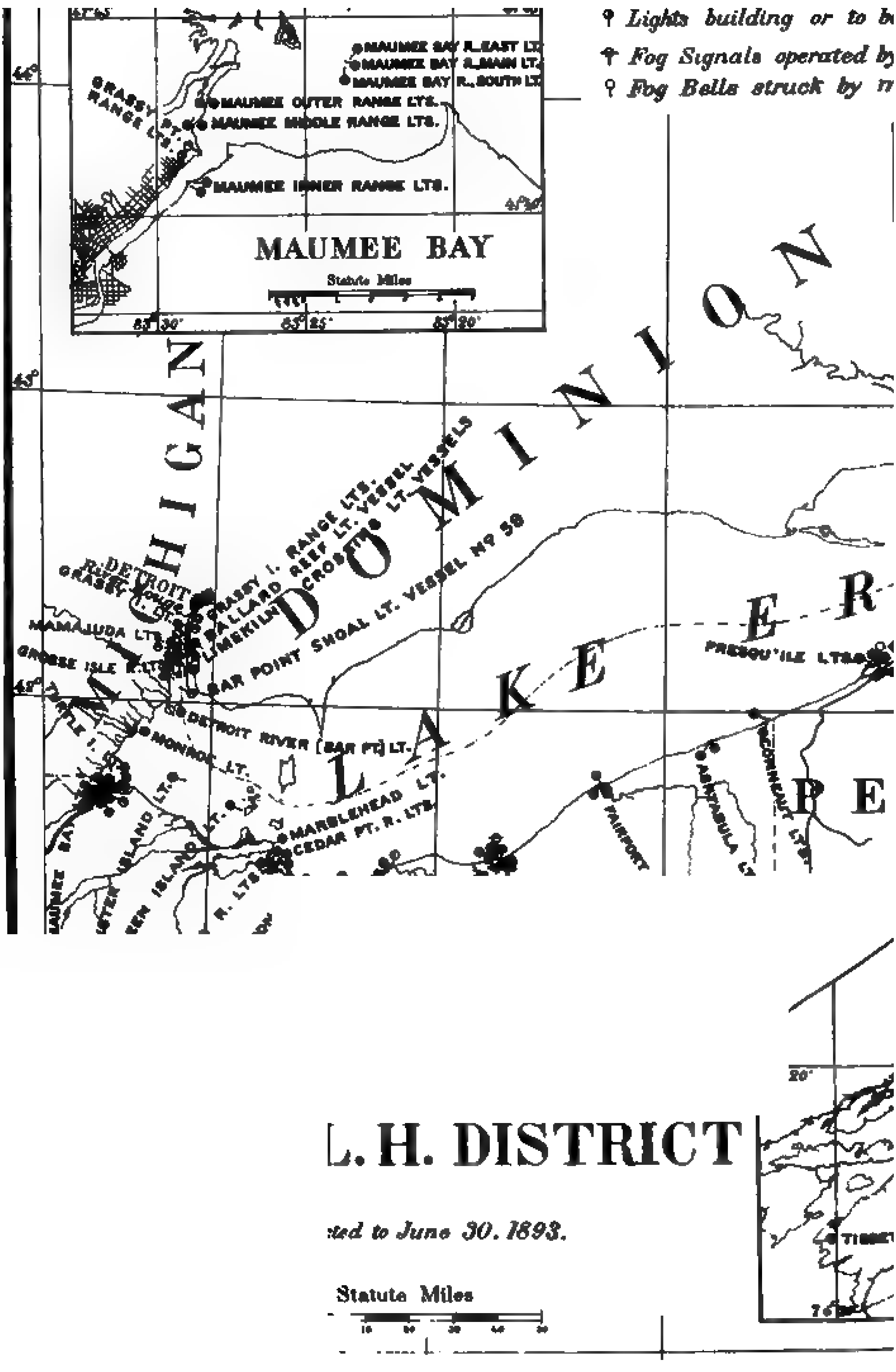
Pointe au Sable, Grand Haven, Kalamazoo, Grossepoint, an, Kenosha, Wind Point, Milwaukee, Port Washington, le Bluff light-stations. She returned to Detroit the surplus s from Waugoshance, Squaw Island, Skilligallee, and also old d machinery at Skilligallee and Sturgeon Bay Canal pierhead

She transferred the ironwork for Chicago Harbor light from moored in the Illinois Central railroad slip at Chicago to the River light-station, and moved the fixed white lens-lantern m the northwest end of the Outer Breakwater, Chicago Har- he Emergency Intake Crib. She was employed June, 1893, ring materials for repairs and improvements at Old Mackinac McGulpin Point, Skilligallee, Little Traverse, Mission Point, th Manitou light-stations. During the working season she 2103 miles with a consumption of 175 tons of coal.



Lights building or to b
Fog Signals operated b
Fog Bells struck by m
MAUMEE BAY R. EAST LT.
MAUMEE BAY R. MAIN LT.
MAUMEE BAY R. SOUTH LT.
GRASSY PT. RANGE LTS.
MAUMEE OUTER RANGE LTS.
MAUMEE MIDDLE RANGE LTS.
MAUMEE INNER RANGE LTS.
MAUMEE BAY
Statute Miles
DOMINION
MICHIGAN
LAKE ERIE
DETROIT
GRASSY I. RANGE LTS.
BALLARD REEF LT. VESSEL
LIMEKILN CROSSING LT. VESSELS
BAR POINT SHOAL LT. VESSEL No 58
MAMAJUDA LTS.
GROSSE ISLE N. LTS.
DETROIT RIVER (BAR PT.) LT.
MONROE LT.
MARBLEHEAD LT.
CEDAR PT. R. LTS.
PRESQU'ILE LTS.
FAIRPORT
ASHTABULA
CONNEAUT LTS.
PE
L. H. DISTRICT
ted to June 30. 1893.
Statute Miles


steam or hot air
achinery
LAKE ONTARIO
OF
NIAGARA RIVER R. L.
FORT NIAGARA LT.
OLCOTT LT.
THIRTY-MILE PT. LT.
OAK ORCHARD LT.
CHARLOTTE H'R LT.
BRADDOCK PT. LT.
GENESEE LT.
BIG SODUS LT.
FAIR HAVEN LT.
FAIR HAVEN R. LT.
OSWEGO LTS.
STONY POINT LT.
GALLOO ISLAND LT.
SACKETTS HARBOR LT.
BUFFALO LTS.
HORSESHOE REEF LT.
DUNKIRK LTS.
NEW YORK
NNA.
OGDENSBURG LT.
CROSS-OVER I. LT.
44°40
45°
41°

TENTH DISTRICT.

The tenth district extends from the mouth of the St. Regis River, New York, to the River Rouge, Detroit River, Michigan, and embraces all the aids to navigation on the American shores and waters of lakes Ontario and Erie, and the St. Lawrence, Niagara, and lower part of Detroit rivers.

Inspector.—Commander Edwin T. Woodward, U. S. Navy, to June 27, 1893; Commander James G. Green, U. S. Navy, from June 27, 1893.

Engineer.—Lieut. Col. Jared A. Smith, Corps of Engineers, U. S. Army.

In this district there are—

Light-houses and beacon lights	71
Fog signals operated by steam	2
Fog signals operated by clockwork	5
Buoys in position	139
Steamer *Haze*, buoy tender, and for supply and inspection	1

The lights in this district are classified as follows:

Third order	6
Fourth order	23
Fifth order	6
Sixth order	20
Tubular lanterns	4
Lens lanterns	4
Reflectors	8
New light established	1
Light discontinued	1
Buoys discontinued	40
New buoys placed	17

All the light-stations and buoys of the district were inspected as frequently as practicable, and the light-stations were supplied with material in May and June.

The engineering work consisted of making repairs at various light-stations, the construction of the metalwork for four circular iron oil houses, the establishment of one pierhead beacon light, and the preliminary work incident to establishing a light-station near Braddock Point, New York, and three steam fog-signal stations and range lights at Manhattan Point, Ohio, Mamajuda, Grosse Isle, and Grassy Island, Michigan.

LIGHT-HOUSES.

1030. *Ogdensburg, St. Lawrence River, New York.*—Repairs and alterations were made in the keeper's dwelling. The well was cleaned. Vari-

Tenth District.

ous minor repairs were made. The materials for a fireproof oil house were purchased at Cleveland, Ohio, and will be shipped to the station by the tender *Haze*.

—. *Bay State Shoal, St. Lawrence River, New York.*—The establishment of temporary floating lights here, at a cost not to exceed $800, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Carlton Island, St. Lawrence River, New York.*—The establishment of this light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1036. Tibbetts Point, St. Lawrence River, New York.—A cistern was built. Various minor repairs were made. The establishment of a steam fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 6, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1038. Galloo Island, Lake Ontario, New York.—Slight repairs were made. The establishment of a steam fog signal, at a cost not to exceed $5,700, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1040. Oswego, entrance to Oswego Harbor, Lake Ontario, New York.—Slight repair was made in the tower. On July 16, 1892, about 2 o'clock p. m., the schooner *Singapore*, while entering Oswego Harbor, struck the pier about 60 feet from the beacon, damaging two large oak stringers and one protection pile. The injury was repaired by the schooner. On November 5, 1892, the schooner *Mystic Star*, while attempting to enter the harbor, damaged the pier, which was repaired by the United States. No claim for this expenditure was made upon the schooner, as the accident seemed unavoidable.

1041. Oswego Breakwater, entrance to Oswego Harbor, New York.—Various minor repairs were made. The following recommendation, which was made in the Board's last three annual reports, is renewed:

> Vessel men complain that they fail to hear this bell ring when the evidence of the keeper proves that it was rung. Captains report that at times they are within half a mile of the bell before they hear it. This uncertainty of a bell as a fog signal is generally admitted. The substitution of a steam fog signal for the bell is, therefore, recommended. It is estimated that it can be established for $4,300, and it is recommended that an appropriation of that amount be made therefor.

1042. Fair Haven, entrance to Little Sodus Bay, New York.—The west pier and elevated walk were injured by the *Lady McDonald*, a vessel which attempted to enter Little Sodus Bay on July 16, 1892.

Tenth District.

She struck the west side of the pier and grounded about 500 feet from the beacon. Slight repairs were made to the barn.

1043. Fair Haven, Little Sodus Bay, New York.—The tubular lantern was replaced by a lantern without tubes. Repairs were made to the elevated walk and inner range light.

1047, 1048. Genesee, Charlotte Harbor, Lake Ontario, New York.—The schooner *Collier* ran into and injured a section of the elevated walk on the west pier, in July, 1892. The damage was repaired by the vessel. The old light-house crib on the west side of the west pier, mouth of the Genesee River, selected as the site for the new fog signal, was put in order for its reception. The boiler and machinery for the fog signal are under contract for delivery by August 15, next. The construction of the fog-signal house was contracted for and is to be completed by September 1, 1893.

1049. Braddock Point, Lake Ontario, New York.—Cession of jurisdiction over this site was obtained from the State of New York under the general law enacted in May, 1892. The reservation was surveyed, the boundaries were marked by stone monuments, the site for the station buildings was selected, the designs for the tower and dwelling are being prepared.

—. Wilson Harbor, Lake Ontario, New York.—The establishment of this light, at a cost not to exceed $2,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1057. Buffalo Breakwater, north end, Lake Erie, New York.—The keeper's dwelling and light tower, which heretofore occupied a position in the center of the crib, were removed to the west corner to provide space for the erection of a fog-signal house. By the act approved August 5, 1892, $4,300 were appropriated to establish this fog signal, and a contract was made for the construction, by August 15, 1893, of the boiler and machinery for a 10-inch steam fog whistle. The fog-signal house should be ready for the reception of the machinery by August 15, 1893.

1062. Presqu'ile Pierhead, Erie Harbor, entrance to Presqu'ile Bay, Lake Erie, Pennsylvania.—The establishment of a steam fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1066. Conneaut Pierhead, entrance to Conneaut Harbor, Lake Erie, Ohio.—This new fixed white light was first shown on November 11, 1892. The color of the structure is white. An eight-day tubular lantern was used for showing the light until the close of navigation, 1892, owing to a delay in the arrival of the lens lantern ordered by the Board. A five-day lens lantern has been used since the opening of navigation in 1893.

Tenth District.

1068. Ashtabula (front), entrance to Ashtabula Harbor, Lake Erie, Ohio.—During a gale on October 28, and 29, 1892, about 30 feet of the elevated walk on the west pier was carried away and about 50 feet was wrecked. The damage was repaired. Some other small repairs were made. The machinery for the new fog signal is under contract for delivery by August 15, 1893, and preparations are being made to build the fog-signal house.

1069. Ashtabula Pierhead (rear), entrance to Ashtabula Harbor, Lake Erie, Ohio.—The illuminating apparatus for this beacon was received but the fitting of the tower was delayed for lack of funds for the purpose. This work will be done during the summer of 1893.

1071. Fairport Pierhead (front), mouth of Grand River, Lake Erie, Ohio.—On November 21, 1892, the steamer *Canisteo*, with the schooner *Stewart* in tow, in entering the harbor during a southwest gale, slightly damaged the wooden beacon on the outer end of the east pier. As the accident occurred while the vessels were making an attempt to enter the harbor for shelter from the gale and was due to stress of weather, no claim for damage was made. The establishment of a steam fog signal at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named, together with $400 for a range light, be appropriated.

1072. Fairport Pierhead (rear), east pier, entrance to Fairport Harbor, mouth of Grand River, Ohio.—The illuminating apparatus for this beacon was received in October, 1892, and was delivered at the station; but for lack of funds the fitting of the tower was not completed. Funds were allotted for the purpose and the beacon will be completed in the summer of 1893.

—. *Cleveland, on the hill at the east side of Cleveland Harbor, Ohio.*—The illuminating apparatus remains in the tower in the same position it occupied before the light was, at the close of navigation in 1892, discontinued. The dwelling is, however, the only place at present provided for the keepers of the harbor lights and fog signal. The house is in the city, at the corner of Main and Water streets, on the high level and affords no view of either of the lights. The distance from the dwelling to the nearest of four lights is about two-thirds of a mile; and to the breakwater light with revolving apparatus and fog signal, the distance is about a mile by the route which must be followed. The distance is a matter of great inconvenience to the keepers, and sometimes of danger to the lights. The present dwelling, though an excellent house, is entirely unsuited to the use of several keepers. It is recommended that a site be constructed at an estimated cost of $10,000 for the dwelling and storehouse by building in the water adjacent to the west pier. The storehouse is much needed. A suitable dwelling can be built in a place convenient to the lights. It is pro-

Tenth District.

posed, when the new dwelling is completed, to sell the old site and buildings. Inquiry regarding value of real estate in the vicinity of the present light-house site and dwelling indicates that the old site may be sold for about $24,000 or $25,000. The expense of the new site, dwelling, and storehouse is estimated to be $25,000, and it is recommended that an appropriation of this amount be made therefor.

1073. Cleveland East Pier, entrance to Cleveland Harbor, Lake Erie, Ohio.—On the night of November 19, 1892, the steamer *Detroit* collided with a schooner and was forced against the east pier. The guards of the steamer, striking the foundation sills of the pierhead beacon, injured them and put the beacon itself in peril. The protection fence across the pier near the beacon was also damaged. The foundation of this beacon was repaired. The protection fence across the pier was restored to its former position, repaired and strengthened with new joists and brace rods.

1075. Cleveland Breakwater, on the east end of the west breakwater, on the west side of the entrance to Cleveland Harbor, Lake Erie, Ohio.—The damage to the timbers of the crib occupied by the fog signal and light-house, inflicted by the steamer *De Pere*, in June, 1892, was repaired at the expense of the steamer. On May 18, 1893, the schooner *J. B. Kitchen*, while being towed into the harbor from the lake, collided with the east end of the west breakwater and did some damage.

1077, 1078. Black River Pierhead range lights, entrance to Black River Harbor, Lake Erie, Ohio.—The illuminating apparatus for showing a light from the rear beacon was duly received. Nearly all the materials for fitting the tower with the hoisting apparatus were provided and the cubby house will soon be finished. On the night of April 21, 1893, at about 11 o'clock, the steamer *C. B. Lockwood*, while entering the harbor, struck the west pier, breaking the timber waling piece which secures the tops of the protection piles, breaking out and displacing eleven or more of the piles, and then came in contact with the rear beacon, slightly bending one leg in the second section. The steamer repaired the tower.

The establishment of a steam fog signal at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1079. Vermillion, on the outer end of the west pier, entrance to Vermillion Harbor, Lake Erie, Ohio.—On April 27, 1893, the light-tower on the west pier was struck by the schooner *M. S. Bacon*, while she was being towed out of the harbor by the steam tug *J. P. Devney*. Two angle-iron plates in the second section of the tower were so badly injured that new plates had to be made to replace them. Many of the joints between the outer plates of the tower were strained, the interior somewhat injured, and one corner of the beacon raised about 2

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inches. The beacon was repaired and a bill for the cost was presented to the owners of the *Devney*. They declined to pay it. The case was turned over to the Department of Justice, that proper legal proceedings might be taken.

1083, 1084, 1085. Sandusky Bay Ranges, on the outer bank at the elbow of the dredged channel, Sandusky Bay, Ohio.—As it was found that the beacons could be better lighted with lens lanterns, the use of gasoline at these ranges was discontinued and the beacons were lighted with 5-day lens lanterns. The gasoline machines were both sold at public auction and the net proceeds were turned into the United States Treasury. Various slight repairs were made. The new straight channel will, it is understood, be completed by midsummer, 1894, and may be ready for use in the fall of 1893. As it is wider, deeper, and more direct than the old channel the latter will be no longer needed. The range lights marking the old channel should, therefore, be moved at once, so as to mark the new channel. There are now two ranges formed by three beacons. Only one range of two beacons will be needed to mark the new channel. The third beacon may be discontinued. This range is very important, as the entire commerce of Sandusky is dependent upon it. The two beacons should be built anew and a dwelling for the keeper should be built near one of the beacons. The beacons should be located on the bar, in water from 5 to 7 feet deep, and on a good foundation. It is estimated that this work can be done at a cost not exceeding $25,000, and the Board recommends that an appropriation of this amount be made therefor.

—. *South Bass Island, Lake Erie, Ohio.*—The establishment of a light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Port Clinton, Lake Erie, Ohio.*—The reëstablishment of a light, at a cost not to exceed $1,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1088. West Sister Island, on the southwest end of West Sister Island, Lake Erie, Ohio.—The roof was rebuilt and slight repairs were made.

1089. Turtle Island, entrance to Maumee Bay, Lake Erie, Ohio.—General repairs were made to the keeper's dwelling. A hand rail was put up in the tower. The old boathouse was rebuilt. The new structure is 16 feet by 26 feet in size. New boat ways lead from the boathouse to the water.

1090, 1091, 1092. Maumee Bay Ranges, Maumee Bay, Lake Erie, Ohio.—The metalwork for a fireproof oil house was delivered on the east pier, Cleveland Harbor, Ohio, from whence it is to be transferred by the light-house tender to the station. The new straight channel through Maumee Bay was dredged to a width of 200 feet and a depth of 17

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feet, and, though somewhat shoaled by drift and sediment, it is better than the old channel. It is about 8 miles long. The Maumee Bay range was not built with reference to the present conditions, but was to light a part of the old channel only 2 miles long. Instead of lighting this single stretch of 2 miles, this range also lights a second stretch of 3 miles in length leading seaward into the lake. As the site of the range is between these two stretches, vessels coming in or going out must pass around the side of the range by a special channel. It is therefore necessary to arrange the beacons so that the channel may be lighted in both directions. The present front beacon is a common portable lantern with small reflectors. At night the lantern is placed on a small platform on the roof of a shed close to the keeper's dwelling, which stands on a crib. The present rear beacon is a lantern on an iron column standing on a crib filled with stone. The distance between the lights is only 1,035 feet. The arrangement is inadequate for future necessities. The channel may be ultimately made 300 feet wide, but the present plans contemplate a width of only 200 feet for the longest reach. The distance between the beacons is already too small for a good range in so long and narrow a channel. The beacons should be made to serve as day marks. This is not the case with the present arrangement. It is therefore necessary to build a new beacon at each end of the range, with lenses to light the entire arc of 360°, and so arranged that both lights will mark the range both outward and inward on the line of the channel. The distance between the beacons may be increased by this arrangement to about 1,240 feet. The keepers must live in a dwelling on a crib at one end of the range, which is now inclosed by a double row of piles and waling pieces extending the entire distance and uniting in points beyond the lights at each end. The place is in the open bay, and a walk between the lights will be a necessity. This range is the most important in this district. When it is completed the light now maintained for the south range may be discontinued. It is estimated that the new range beacons and walk can be built for not exceeding $15,000, and it is recommended that this amount be appropriated for that purpose.

—. *Grassy Point Range Lights, Straight Channel, Maumee Bay, Ohio.*—By act approved March 3, 1893, $8,000 was appropriated for moving the range lights, Maumee River, Ohio, so as to light properly the new straight channel. The land for a site for the rear beacon of the range and for the keeper's dwelling was selected on Manhattan Point, North Toledo, Ohio. The title papers are under examination. The condition of the channel is explained under the heading of Maumee Bay range. The new range is to light the channel from the end next to the mouth of the river, and when this is done, the Maumee Inner, Maumee Middle, and Maumee Outer ranges may be discontinued. The

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front beacon is to be erected in the water. While the beacon may be built and furnished with illuminating apparatus on the balance of the appropriation, about $7,000, it is not enough to build suitable structures, as the site for the rear beacon will require to be graded and protected from the river currents. The Board, therefore, recommends that an additional appropriation of $2,000 be made for this purpose.

1099. Monroe, entrance to River Raisin, Lake Erie, Michigan.—The keeper's dwelling was put in good repair. During a heavy northeast gale on April 19 and 20, 1893, much damage was done to the light-house and premises which was repaired. A foundation was made for a circular iron oil house at a point about 21 feet west from the keeper's dwelling on the north side of the pier. The metalwork for the oil house was made under contract and was delivered at Cleveland, ready for shipment to the site by the light-house tender *Haze*.

—. Ballards Reef Light-House, Detroit River, Michigan.—The following recommendation made in the Board's last annual report is renewed:

> The need for a light is shown by the fact that private lights are kept up in a certain way at this reef. The Board is of opinion that a light-house should be built on a caisson at this point, as nothing of less strength would be able to resist the ice running with the river. It is estimated that a proper structure can be built here for not exceeding $100,000, and it is recommended that an appropriation of that amount be made therefor.

1108, 1109. Mamajuda Range Light, Michigan.—An appropriation of $1,500 for the establishment of this light was made by the act approved August 5, 1892. The purpose of this light is to form with the present light on Mamajuda Island a range to mark the channel between Grassy and Mamajuda islands. A survey was made and the range line was located from Mamajuda Light to a point in the channel opposite Grassy Island Light. A map was made showing the range line with soundings and the location selected for the new beacon. Plans for the proposed beacon were made.

1104, 1105. Grosse Isle Range Lights, Detroit River, Michigan.—By the act approved on August 5, 1892, $2,500 was appropriated for the establishment of these lights to make a range to mark the center of the channel from the foot of Fighting Island to Mamajuda Light. A survey was made in the Detroit River, Michigan, to determine the location for the range line and the sites for the beacons of the range. The line for the range was definitely located and the sites for the beacons were determined. A map was prepared showing the results of a hydrographic survey. The title papers were placed under examination. The rear beacon of this range is to be on land. The beacon will be high enough to be seen over the tops of the trees. The front beacon is to stand in the water. A new dwelling is needed for the keeper of this

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range. He is now living in a dwelling on Mamajuda, which is not only unsuitable for the purpose but is too far away. It is deemed dangerous for the keeper to live on the side of the channel opposite to the lights. A proper dwelling can be built on a foundation partially in the water for not exceeding $5,000, and it is recommended that this amount be appropriated for that purpose.

—. *Grassy Island South End Range, on or near Grassy Island, Detroit River, Michigan.*—A light is needed in connection with Grassy Island Light, to form a range south from Grassy Island to intersect the new Grosse Isle Range, at a point in the channel opposite to Mamajuda light-house. A proper beacon light can be established on the little island where the Grassy Island fisheries are situated for not exceeding $700, and it is recommended that an appropriation of this amount be made therefor.

1111, 1112. Grassy Island Range Lights, Detroit River, Michigan.—Congress, by act of August 5, 1892, appropriated $1,500 for the establishment of range lights above Grassy Island, Detroit River, Michigan. The range line passes 350 feet outside and west of the contour of 18 feet depth, in the channel near the head of Fighting Island, and intersects the Mamajuda Range, as previously established, at a point immediately opposite Grassy Island Light-House. To avoid expensive sites on the land submarine sites for the beacons of this range were selected upon the river flats in front of Ecorse, Mich. Measures have been taken to obtain title and cession of jurisdiction to the United States.

The amount, $1,500, appropriated by the act above referred to is insufficient to build the kind of beacons needed at this place. Some expense was incurred necessarily in making a hydrographic survey of the river and in fixing the site where the beacons should be located. It is now found that an additional amount of $1,500 is needed to finish this work, and it is recommended that an appropriation of that amount be made for this purpose.

—. *Grassy Island North End Range, on Grassy Island, Detroit River, Michigan.*—When a vessel leaves Detroit for Lake Erie it is carried by the direction of the channel and the current of the river toward the head of Fighting Island, which is low and has flats covered with water, extending 800 feet or more from the shore line toward the channel on the west side of the island near its north end. It is proposed to place range lights to mark the channel, so that vessels may take a more direct and certain course and avoid the danger of running upon the flats. In going up the river the same range will indicate the point at which the range past Grassy Island may be dropped with certainty of clearing the flats off Fighting Island. It is estimated that this range can be established for not exeeding $5,500, and the Board recommends that an appropriation of this amount be made therefor.

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REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

1031. Cross-Over Island, N. Y.
1033. Sunken Rock, N. Y.
1037. Sacketts Harbor, N. Y.
1045, 1046. Big Sodus, N. Y.
1050. Oak Orchard, N. Y.
1051. Thirty-Mile Point, N. Y.
1053. Fort Niagara, N. Y.
1056. Horseshoe Reef, N. Y.
1058. Buffalo, N. Y.
1086. Marblehead, Ohio.
1101. Detroit River (Bar Point), Mich.
1110. Grassy Island, Mich.

OIL HOUSES.

Oil houses, or detached fireproof places for the storage of mineral oil, are needed at a large number of the light-stations in the district. The average cost of such oil houses is about $350 each. The metal-work for four houses was completed during the past year and now awaits shipment to the various stations by the light-house tender *Haze*.

LIGHT-VESSELS.

1102, 1103. Limekiln Crossing, North and South light-vessels, Detroit River, Michigan.—Temporary floating lights were maintained here, at a cost of $1,000, during the year by contract with the Lake Carriers' Association. By the sundry civil appropriation act approved August 5, 1892. $8,600 was appropriated "for the construction or purchase, equipment, and maintenance of three small light-vessels for use in the Detroit River." It was proposed to place one of these vessels at each end of the Limekiln Crossing, as this cut which had been made by the United States at great expense was used mainly by United States shipping. As this channel is entirely in Canadian waters the light-vessels might not be placed and maintained there without the consent of the Canadian Government. This was obtained in due course of time. The vessels were built by contract near Detroit. They are scow-shaped, of wood, and are 40 feet long, of 12 feet beam, 4 feet deep amidships, with 9 inches shear. They will each carry one light shown from a tubular lantern. It is hoped that these cheap and temporary vessels may last until Congress makes arrangements for the permanent lighting of this important channel.*

—. *Ballards Reef light-vessel, No. 63, Detroit River, Michigan.*—A temporary floating light was maintained here during the year, at a cost of $800, by contract with the Lake Carriers' Association. By the sundry civil act approved on August 5, 1892, $8,600 was appropriated "for the construction or purchase, equipment, and maintenance of three small light-vessels for use in the Detroit River, Michigan." These light-vessels were built under contract near Detroit, Mich. They have the same

* These vessels were placed in their respective positions on September 15, 1893.

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shape and dimensions as those built for the Limekiln Crossing. They will each show a light from a tubular lantern similar to those used on post lights. One of these cheaply-built vessels was placed on Ballards Reef. This vessel shows a fixed red light. It is intended for temporary use only, and it is hoped that it may be replaced in due time by a permanent light house, as is recommended elsewhere.*

—. *Bar Point light-vessel, No. 59, mouth of Detroit River, Lake Erie.*—By the sundry civil act, approved on August 5, 1892, $25,000 was appropriated "for a light-ship to take the place of the light-ship now maintained by private owners at Bar Point, Lake Erie, to be located in American waters at a point to be determined by the Light-House Board." After due advertisement a contract was made with the lowest bidder for building this light-vessel at Toledo, Ohio. The contract was approved on March 29, 1893, and it required that the light-vessel be delivered in four calendar months from that date, which makes her due on July 29, 1893. She is to be built of wood, 80 feet 9 inches long, 21 feet 6 inches beam, and 9 feet 5 inches depth of hold, with a displacement of about 195 tons. As a fog signal she is to have a 6-inch steam whistle actuated by a Warrington water-tube boiler, able to get up sufficient steam to commence signaling in fifteen minutes from the time the fire is lighted. The characteristic of this fog signal is a blast of ten seconds, followed by a silent interval of thirty seconds, repeated continually during the fog. The vessel is to be painted black, with her name and number on her bows and stern in large, white letters. She is to be lighted by a cluster of three lights showing around 240° of the horizon. It is expected that she will be placed on her station early in September next.†

FOG SIGNALS OPERATED BY STEAM OR HOT AIR.

1075. Cleveland Breakwater (east end), Lake Erie, Ohio.—This 10-inch steam whistle was in use some 401 hours, and about 33½ tons of bituminous coal were consumed.

1101. Detroit River (Bar Point), Lake Erie, Michigan.—This 10-inch steam whistle was in use 118 hours, and about 8½ tons of coal were consumed. The duration of fog is reported as 140¾ hours, during which time steam was up or was being made.

The five fog bells of the district are in good condition, and the machinery operating them is working well.

BUOYAGE.

The buoyage of the district is in good condition. The tender *Haze* cared for the buoys in Lake Erie and Detroit River, and placed those

*This light-vessel was placed in her position on July 1, 1893.

†The Bar Point light-vessel was placed on her station on September 20, 1893.

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ous minor repairs were made. The materials for a fireproof oil house were purchased at Cleveland, Ohio, and will be shipped to the station by the tender *Haze*.

—. *Bay State Shoal, St. Lawrence River, New York.*—The establishment of temporary floating lights here, at a cost not to exceed $800, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Carlton Island, St. Lawrence River, New York.*—The establishment of this light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1036. Tibbetts Point, St. Lawrence River, New York.—A cistern was built. Various minor repairs were made. The establishment of a steam fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 6, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1038. Galloo Island, Lake Ontario, New York.—Slight repairs were made. The establishment of a steam fog signal, at a cost not to exceed $5,700, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1040. Oswego, entrance to Oswego Harbor, Lake Ontario, New York.—Slight repair was made in the tower. On July 16, 1892, about 2 o'clock p. m., the schooner *Singapore*, while entering Oswego Harbor, struck the pier about 60 feet from the beacon, damaging two large oak stringers and one protection pile. The injury was repaired by the schooner. On November 5, 1892, the schooner *Mystic Star*, while attempting to enter the harbor, damaged the pier, which was repaired by the United States. No claim for this expenditure was made upon the schooner, as the accident seemed unavoidable.

1041. Oswego Breakwater, entrance to Oswego Harbor, New York.—Various minor repairs were made. The following recommendation, which was made in the Board's last three annual reports, is renewed:

> Vessel men complain that they fail to hear this bell ring when the evidence of the keeper proves that it was rung. Captains report that at times they are within half a mile of the bell before they hear it. This uncertainty of a bell as a fog signal is generally admitted. The substitution of a steam fog signal for the bell is, therefore, recommended. It is estimated that it can be established for $4,300, and it is recommended that an appropriation of that amount be made therefor.

1042. Fair Haven, entrance to Little Sodus Bay, New York.—The west pier and elevated walk were injured by the *Lady McDonald*, a vessel which attempted to enter Little Sodus Bay on July 16, 1892.

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She struck the west side of the pier and grounded about 500 feet from the beacon. Slight repairs were made to the barn.

1043. Fair Haven, Little Sodus Bay, New York.—The tubular lantern was replaced by a lantern without tubes. Repairs were made to the elevated walk and inner range light.

1047, 1048. Genesee, Charlotte Harbor, Lake Ontario, New York.—The schooner *Collier* ran into and injured a section of the elevated walk on the west pier, in July, 1892. The damage was repaired by the vessel. The old light-house crib on the west side of the west pier, mouth of the Genesee River, selected as the site for the new fog signal, was put in order for its reception. The boiler and machinery for the fog signal are under contract for delivery by August 15, next. The construction of the fog-signal house was contracted for and is to be completed by September 1, 1893.

1049. Braddock Point, Lake Ontario, New York.—Cession of jurisdiction over this site was obtained from the State of New York under the general law enacted in May, 1892. The reservation was surveyed, the boundaries were marked by stone monuments, the site for the station buildings was selected, the designs for the tower and dwelling are being prepared.

—. Wilson Harbor, Lake Ontario, New York.—The establishment of this light, at a cost not to exceed $2,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1057. Buffalo Breakwater, north end, Lake Erie, New York.—The keeper's dwelling and light tower, which heretofore occupied a position in the center of the crib, were removed to the west corner to provide space for the erection of a fog-signal house. By the act approved August 5, 1892, $4,300 were appropriated to establish this fog signal, and a contract was made for the construction, by August 15, 1893, of the boiler and machinery for a 10-inch steam fog whistle. The fog-signal house should be ready for the reception of the machinery by August 15, 1893.

1062. Presqu 'ile Pierhead, Erie Harbor, entrance to Presqu 'ile Bay, Lake Erie, Pennsylvania.—The establishment of a steam fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1066. Conneaut Pierhead, entrance to Conneaut Harbor, Lake Erie, Ohio.—This new fixed white light was first shown on November 11, 1892. The color of the structure is white. An eight-day tubular lantern was used for showing the light until the close of navigation, 1892, owing to a delay in the arrival of the lens lantern ordered by the Board. A five-day lens lantern has been used since the opening of navigation in 1893.

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1068. Ashtabula (front), entrance to Ashtabula Harbor, Lake Erie, Ohio.—During a gale on October 28, and 29, 1892, about 30 feet of the elevated walk on the west pier was carried away and about 50 feet was wrecked. The damage was repaired. Some other small repairs were made. The machinery for the new fog signal is under contract for delivery by August 15, 1893, and preparations are being made to build the fog-signal house.

1069. Ashtabula Pierhead (rear), entrance to Ashtabula Harbor, Lake Erie, Ohio.—The illuminating apparatus for this beacon was received but the fitting of the tower was delayed for lack of funds for the purpose. This work will be done during the summer of 1893.

1071. Fairport Pierhead (front), mouth of Grand River, Lake Erie, Ohio.—On November 21, 1892, the steamer *Canisteo*, with the schooner *Stewart* in tow, in entering the harbor during a southwest gale, slightly damaged the wooden beacon on the outer end of the east pier. As the accident occurred while the vessels were making an attempt to enter the harbor for shelter from the gale and was due to stress of weather, no claim for damage was made. The establishment of a steam fog signal at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named, together with $400 for a range light, be appropriated.

1072. Fairport Pierhead (rear), east pier, entrance to Fairport Harbor, mouth of Grand River, Ohio.—The illuminating apparatus for this beacon was received in October, 1892, and was delivered at the station; but for lack of funds the fitting of the tower was not completed. Funds were allotted for the purpose and the beacon will be completed in the summer of 1893.

—. *Cleveland, on the hill at the east side of Cleveland Harbor, Ohio.*—The illuminating apparatus remains in the tower in the same position it occupied before the light was, at the close of navigation in 1892, discontinued. The dwelling is, however, the only place at present provided for the keepers of the harbor lights and fog signal. The house is in the city, at the corner of Main and Water streets, on the high level and affords no view of either of the lights. The distance from the dwelling to the nearest of four lights is about two-thirds of a mile; and to the breakwater light with revolving apparatus and fog signal, the distance is about a mile by the route which must be followed. The distance is a matter of great inconvenience to the keepers, and sometimes of danger to the lights. The present dwelling, though an excellent house, is entirely unsuited to the use of several keepers. It is recommended that a site be constructed at an estimated cost of $10,000 for the dwelling and storehouse by building in the water adjacent to the west pier. The storehouse is much needed. A suitable dwelling can be built in a place convenient to the lights. It is pro-

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posed, when the new dwelling is completed, to sell the old site and buildings. Inquiry regarding value of real estate in the vicinity of the present light-house site and dwelling indicates that the old site may be sold for about $24,000 or $25,000. The expense of the new site, dwelling, and storehouse is estimated to be $25,000, and it is recommended that an appropriation of this amount be made therefor.

1073. Cleveland East Pier, entrance to Cleveland Harbor, Lake Erie, Ohio.—On the night of November 19, 1892, the steamer *Detroit* collided with a schooner and was forced against the east pier. The guards of the steamer, striking the foundation sills of the pierhead beacon, injured them and put the beacon itself in peril. The protection fence across the pier near the beacon was also damaged. The foundation of this beacon was repaired. The protection fence across the pier was restored to its former position, repaired and strengthened with new joists and brace rods.

1075. Cleveland Breakwater, on the east end of the west breakwater, on the west side of the entrance to Cleveland Harbor, Lake Erie, Ohio.—The damage to the timbers of the crib occupied by the fog signal and light-house, inflicted by the steamer *De Pere*, in June, 1892, was repaired at the expense of the steamer. On May 18, 1893, the schooner *J. B. Kitchen*, while being towed into the harbor from the lake, collided with the east end of the west breakwater and did some damage.

1077, 1078. Black River Pierhead range lights, entrance to Black River Harbor, Lake Erie, Ohio.—The illuminating apparatus for showing a light from the rear beacon was duly received. Nearly all the materials for fitting the tower with the hoisting apparatus were provided and the cubby house will soon be finished. On the night of April 21, 1893, at about 11 o'clock, the steamer *C. B. Lockwood*, while entering the harbor, struck the west pier, breaking the timber waling piece which secures the tops of the protection piles, breaking out and displacing eleven or more of the piles, and then came in contact with the rear beacon, slightly bending one leg in the second section. The steamer repaired the tower.

The establishment of a steam fog signal at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1079. Vermillion, on the outer end of the west pier, entrance to Vermillion Harbor, Lake Erie, Ohio.—On April 27, 1893, the light-tower on the west pier was struck by the schooner *M. S. Bacon*, while she was being towed out of the harbor by the steam tug *J. P. Devney*. Two angle-iron plates in the second section of the tower were so badly injured that new plates had to be made to replace them. Many of the joints between the outer plates of the tower were strained, the interior somewhat injured, and one corner of the beacon raised about 2

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inches. The beacon was repaired and a bill for the cost was presented to the owners of the *Devney*. They declined to pay it. The case was turned over to the Department of Justice, that proper legal proceedings might be taken.

1083, 1084, 1085. Sandusky Bay Ranges, on the outer bank at the elbow of the dredged channel, Sandusky Bay, Ohio.—As it was found that the beacons could be better lighted with lens lanterns, the use of gasoline at these ranges was discontinued and the beacons were lighted with 5-day lens lanterns. The gasoline machines were both sold at public auction and the net proceeds were turned into the United States Treasury. Various slight repairs were made. The new straight channel will, it is understood, be completed by midsummer, 1894, and may be ready for use in the fall of 1893. As it is wider, deeper, and more direct than the old channel the latter will be no longer needed. The range lights marking the old channel should, therefore, be moved at once, so as to mark the new channel. There are now two ranges formed by three beacons. Only one range of two beacons will be needed to mark the new channel. The third beacon may be discontinued. This range is very important, as the entire commerce of Sandusky is dependent upon it. The two beacons should be built anew and a dwelling for the keeper should be built near one of the beacons. The beacons should be located on the bar, in water from 5 to 7 feet deep, and on a good foundation. It is estimated that this work can be done at a cost not exceeding $25,000, and the Board recommends that an appropriation of this amount be made therefor.

—. *South Bass Island, Lake Erie, Ohio.*—The establishment of a light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Port Clinton, Lake Erie, Ohio.*—The reëstablishment of a light, at a cost not to exceed $1,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1088. West Sister Island, on the southwest end of West Sister Island, Lake Erie, Ohio.—The roof was rebuilt and slight repairs were made.

1089. Turtle Island, entrance to Maumee Bay, Lake Erie, Ohio.—General repairs were made to the keeper's dwelling. A hand rail was put up in the tower. The old boathouse was rebuilt. The new structure is 16 feet by 26 feet in size. New boat ways lead from the boathouse to the water.

1090, 1091, 1092. Maumee Bay Ranges, Maumee Bay, Lake Erie, Ohio.—The metalwork for a fireproof oil house was delivered on the east pier, Cleveland Harbor, Ohio, from whence it is to be transferred by the light-house tender to the station. The new straight channel through Maumee Bay was dredged to a width of 200 feet and a depth of 17

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feet, and, though somewhat shoaled by drift and sediment, it is better than the old channel. It is about 8 miles long. The Maumee Bay range was not built with reference to the present conditions, but was to light a part of the old channel only 2 miles long. Instead of lighting this single stretch of 2 miles, this range also lights a second stretch of 3 miles in length leading seaward into the lake. As the site of the range is between these two stretches, vessels coming in or going out must pass around the side of the range by a special channel. It is therefore necessary to arrange the beacons so that the channel may be lighted in both directions. The present front beacon is a common portable lantern with small reflectors. At night the lantern is placed on a small platform on the roof of a shed close to the keeper's dwelling, which stands on a crib. The present rear beacon is a lantern on an iron column standing on a crib filled with stone. The distance between the lights is only 1,035 feet. The arrangement is inadequate for future necessities. The channel may be ultimately made 300 feet wide, but the present plans contemplate a width of only 200 feet for the longest reach. The distance between the beacons is already too small for a good range in so long and narrow a channel. The beacons should be made to serve as day marks. This is not the case with the present arrangement. It is therefore necessary to build a new beacon at each end of the range, with lenses to light the entire arc of 360°, and so arranged that both lights will mark the range both outward and inward on the line of the channel. The distance between the beacons may be increased by this arrangement to about 1,240 feet. The keepers must live in a dwelling on a crib at one end of the range, which is now inclosed by a double row of piles and waling pieces extending the entire distance and uniting in points beyond the lights at each end. The place is in the open bay, and a walk between the lights will be a necessity. This range is the most important in this district. When it is completed the light now maintained for the south range may be discontinued. It is estimated that the new range beacons and walk can be built for not exceeding $15,000, and it is recommended that this amount be appropriated for that purpose.

—. *Grassy Point Range Lights, Straight Channel, Maumee Bay, Ohio.*—By act approved March 3, 1893, $8,000 was appropriated for moving the range lights, Maumee River, Ohio, so as to light properly the new straight channel. The land for a site for the rear beacon of the range and for the keeper's dwelling was selected on Manhattan Point, North Toledo, Ohio. The title papers are under examination. The condition of the channel is explained under the heading of Maumee Bay range. The new range is to light the channel from the end next to the mouth of the river, and when this is done, the Maumee Inner, Maumee Middle, and Maumee Outer ranges may be discontinued. The

front beacon is to be erected in the water. While the beacon may be built and furnished with illuminating apparatus on the balance of the appropriation, about $7,000, it is not enough to build suitable structures, as the site for the rear beacon will require to be graded and protected from the river currents. The Board, therefore, recommends that an additional appropriation of $2,000 be made for this purpose.

1099. Monroe, entrance to River Raisin, Lake Erie, Michigan.—The keeper's dwelling was put in good repair. During a heavy northeast gale on April 19 and 20, 1893, much damage was done to the light-house and premises which was repaired. A foundation was made for a circular iron oil house at a point about 21 feet west from the keeper's dwelling on the north side of the pier. The metalwork for the oil house was made under contract and was delivered at Cleveland, ready for shipment to the site by the light-house tender *Haze.*

—. Ballards Reef Light-House, Detroit River, Michigan.—The following recommendation made in the Board's last annual report is renewed:

> The need for a light is shown by the fact that private lights are kept up in a certain way at this reef. The Board is of opinion that a light-house should be built on a caisson at this point, as nothing of less strength would be able to resist the ice running with the river. It is estimated that a proper structure can be built here for not exceeding $100,000, and it is recommended that an appropriation of that amount be made therefor.

1108, 1109. Mamajuda Range Light, Michigan.—An appropriation of $1,500 for the establishment of this light was made by the act approved August 5, 1892. The purpose of this light is to form with the present light on Mamajuda Island a range to mark the channel between Grassy and Mamajuda islands. A survey was made and the range line was located from Mamajuda Light to a point in the channel opposite Grassy Island Light. A map was made showing the range line with soundings and the location selected for the new beacon. Plans for the proposed beacon were made.

1104, 1105. Grosse Isle Range Lights, Detroit River, Michigan.—By the act approved on August 5, 1892, $2,500 was appropriated for the establishment of these lights to make a range to mark the center of the channel from the foot of Fighting Island to Mamajuda Light. A survey was made in the Detroit River, Michigan, to determine the location for the range line and the sites for the beacons of the range. The line for the range was definitely located and the sites for the beacons were determined. A map was prepared showing the results of a hydrographic survey. The title papers were placed under examination. The rear beacon of this range is to be on land. The beacon will be high enough to be seen over the tops of the trees. The front beacon is to stand in the water. A new dwelling is needed for the keeper of this

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range. He is now living in a dwelling on Mamajuda, which is not only unsuitable for the purpose but is too far away. It is deemed dangerous for the keeper to live on the side of the channel opposite to the lights. A proper dwelling can be built on a foundation partially in the water for not exceeding $5,000, and it is recommended that this amount be appropriated for that purpose.

—. *Grassy Island South End Range, on or near Grassy Island, Detroit River, Michigan.*—A light is needed in connection with Grassy Island Light, to form a range south from Grassy Island to intersect the new Grosse Isle Range, at a point in the channel opposite to Mamajuda light-house. A proper beacon light can be established on the little island where the Grassy Island fisheries are situated for not exceeding $700, and it is recommended that an appropriation of this amount be made therefor.

1111, 1112. Grassy Island Range Lights, Detroit River, Michigan.—Congress, by act of August 5, 1892, appropriated $1,500 for the establishment of range lights above Grassy Island, Detroit River, Michigan. The range line passes 350 feet outside and west of the contour of 18 feet depth, in the channel near the head of Fighting Island, and intersects the Mamajuda Range, as previously established, at a point immediately opposite Grassy Island Light-House. To avoid expensive sites on the land submarine sites for the beacons of this range were selected upon the river flats in front of Ecorse, Mich. Measures have been taken to obtain title and cession of jurisdiction to the United States.

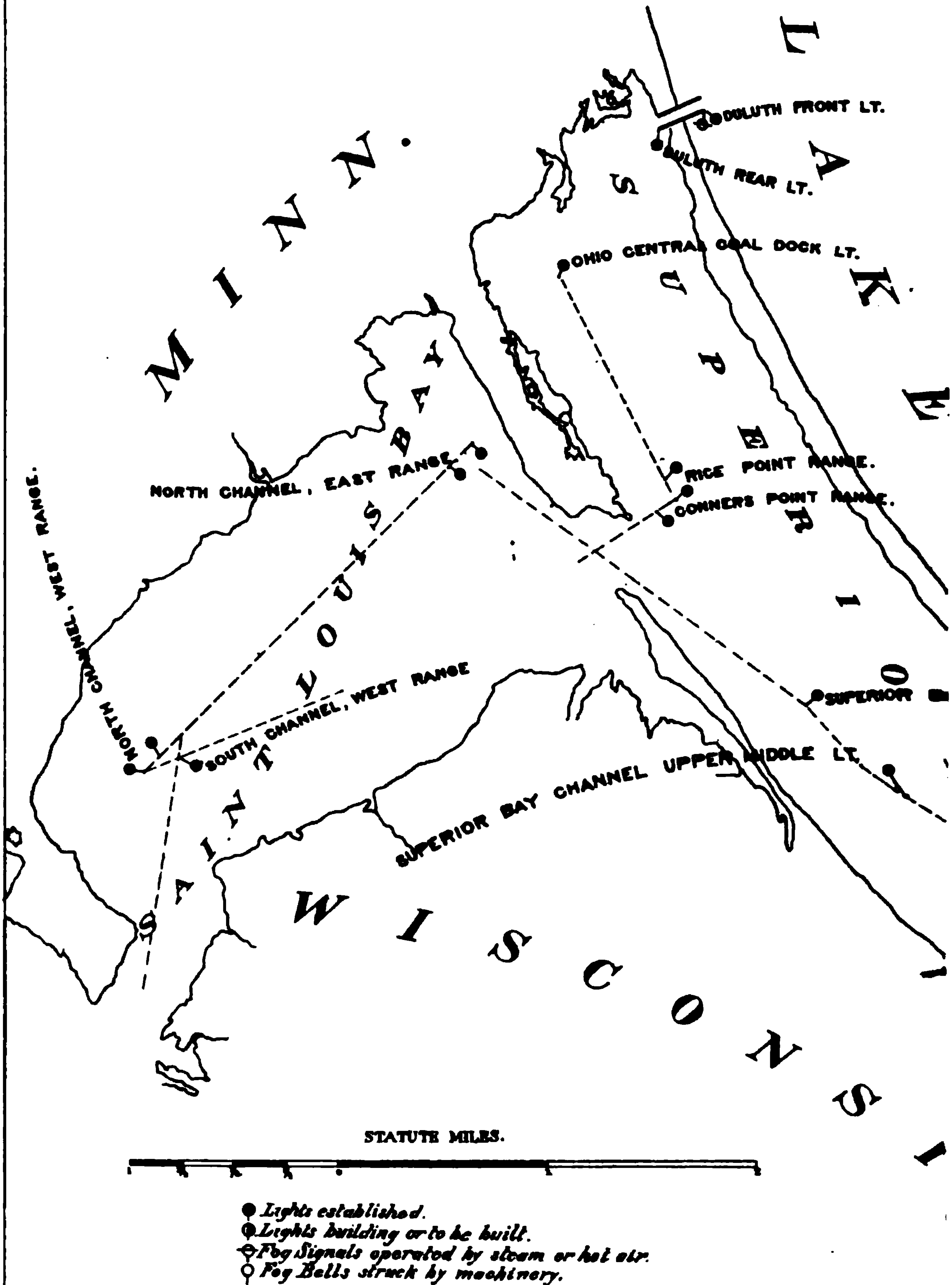
The amount, $1,500, appropriated by the act above referred to is insufficient to build the kind of beacons needed at this place. Some expense was incurred necessarily in making a hydrographic survey of the river and in fixing the site where the beacons should be located. It is now found that an additional amount of $1,500 is needed to finish this work, and it is recommended that an appropriation of that amount be made for this purpose.

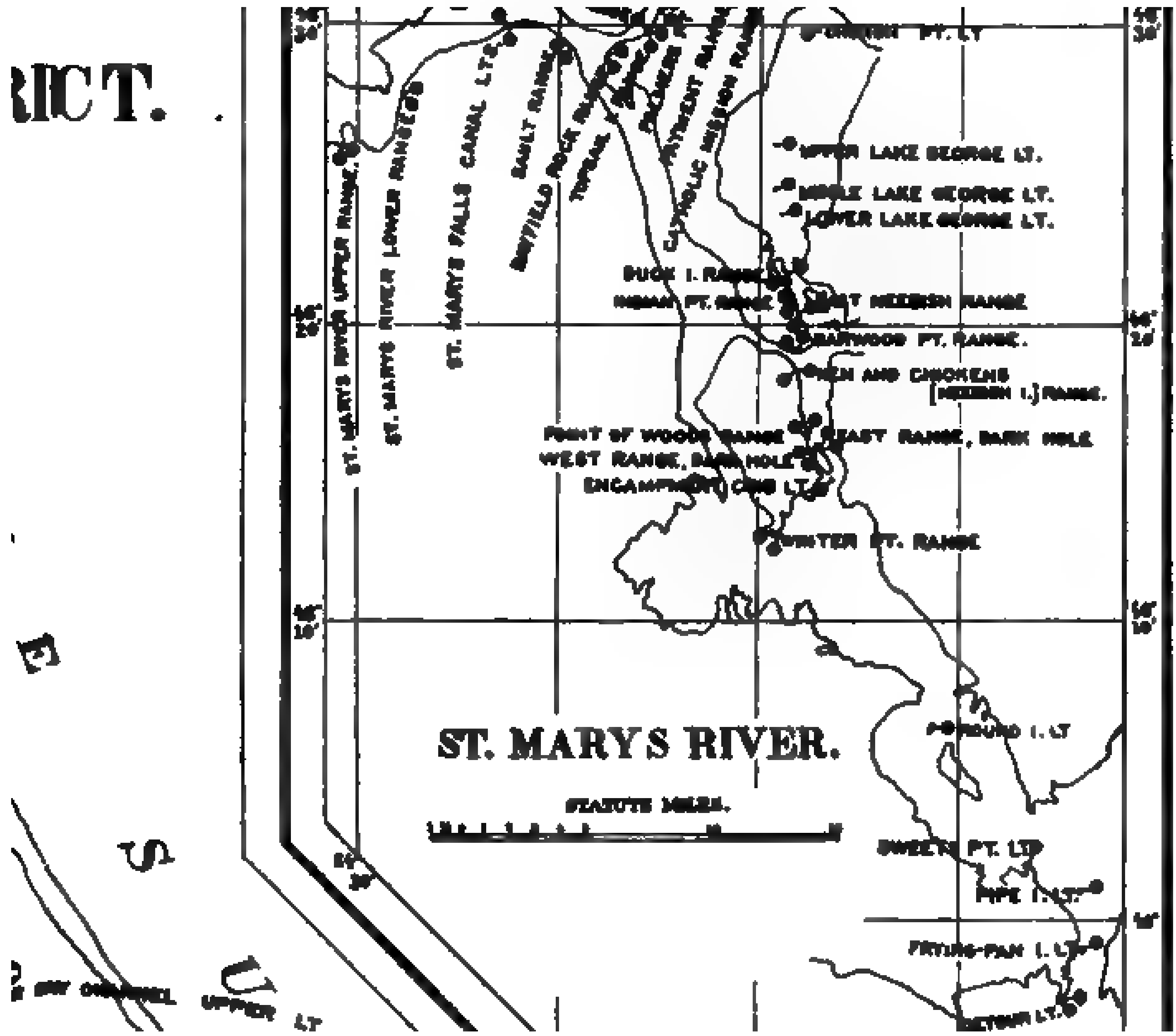
—. *Grassy Island North End Range, on Grassy Island, Detroit River, Michigan.*—When a vessel leaves Detroit for Lake Erie it is carried by the direction of the channel and the current of the river toward the head of Fighting Island, which is low and has flats covered with water, extending 800 feet or more from the shore line toward the channel on the west side of the island near its north end. It is proposed to place range lights to mark the channel, so that vessels may take a more direct and certain course and avoid the danger of running upon the flats. In going up the river the same range will indicate the point at which the range past Grassy Island may be dropped with certainty of clearing the flats off Fighting Island. It is estimated that this range can be established for not exeeding $5,500, and the Board recommends that an appropriation of this amount be made therefor.

ENLARGED PARTS OF

ELEVENTH L. H. DISTRI

Corrected to June 30, 1893.




RICT.
ST. MARYS RIVER.
UPPER LAKE GEORGE LT.
LOWER LAKE GEORGE LT.
DUCK I. RANGE
WEST NEEBISH RANGE
HARWOOD PT. RANGE.
HEN AND CHICKENS
POINT OF WOODS RANGE
EAST RANGE, DARK HOLE
WEST RANGE, DARK HOLE
WINTER PT. RANGE
ST. MARYS FALLS CANAL LTS.
ST. MARYS RIVER LOWER RANGES
ST. MARYS RIVER UPPER RANGE
CATHOLIC MISSION RANGE
SWEETS PT. LT.
PIPE I. LT.
FRYING-PAN I. LT.
UPPER LT

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is to be completed early in the spring of 1894. This channel will be 300 feet wide with a depth of 21 feet, thus affording the most direct route into Lake Superior, and a route which will be used by most of the vessels navigating these waters. There is a good 18-foot channel to the westward of the shoal now marked by the red can buoy known as the Waiska Bay buoy and a black spar buoy, but with the completion of the 21-foot channel, which is already lighted by the upper range lights, the necessity for additional lights in that locality, or for any change in the present lights, is avoided.

It is therefore recommended that the $5,000 appropriated by the act approved August 5, 1892, for moving the St. Marys River Upper Range lights be made available for completing the structures at Seul Choix Pointe light-station, Michigan.

1211. Point Iroquois, Lake Superior, Michigan.—A circular iron oil house was built.

1212. Whitefish Point, Lake Michigan, Michigan.—The characteristic of this light was changed on June 15, 1893, from a fixed white light to a fixed white light varied by a red flash every twenty seconds. A circular iron oil house was built.

—. Grand Marais, Harbor of Refuge, Lake Superior, Michigan.—The establishment of a light and bell here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1213. Big Sable, Lake Superior, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. Big Bay Point, between Granite and Huron Islands, Michigan.—The establishment of a light and fog signal here, at a cost not to exceed $25,000 was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. Mendota, Bete Grise Bay, entrance to Lac la Belle, Lake Superior, Michigan.—The establishment of a light here, at a cost not to exceed $7,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1232. Eagle Harbor, Lake Superior, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no apppropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1235. Eagle River, Lake Superior, Michigan.—The moving of this light to Sand Hills, at a cost not to exceed $20,000, was authorized by

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the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1237. Portage Lake Ship Canal Pierhead, Lake Superior, Michigan.—The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Fourteen-Mile Point, Lake Superior, Michigan.*—An appropriation of $20,000 was made by Congress March 3, 1893, for the establishment of this light and fog signal. Preliminary plans, together with a general description of the station and detailed estimate of cost, were prepared, and a site was adopted after a careful examination of the vicinity. Measures were taken to obtain title to the land. Preliminary work at the station may be commenced during this working season, and the structures begun early next spring.

—. *Chequamegon Light and Fog Signal, Lake Superior, Wisconsin.*—The removing and rebuilding of the main light and the establishment of a harbor light and bell, at a cost not to exceed $10,000, were authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Bayfield, Lake Superior, Wisconsin.*—The establishment of a light here, at a cost not to exceed $5,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1245. Devils Island, Apostle Group, Lake Superior, Wisconsin.—As reported to the Board under date of June 5, 1892, this island was appraised in the sum of $1,600 by the commission appointed for that purpose, and the necessary proceedings were taken to have the findings of the commissioners confirmed and decree made.

The completing of the light-station here, at a cost not to exceed $22,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1247. Superior Pierhead, Lake Superior, Wisconsin.—The beacon was moved from the Minnesota to the Wisconsin side of the entrance to Superior Bay. An elevated walk was built on the pier to give access to the beacon in stormy weather. Plans, specifications, and estimate of cost for the transfer of the keeper's dwelling were prepared. A first-class fog signal is needed to guide the mariner to the entrance of this harbor in thick or foggy weather when the light can not be seen at night nor the structures of the station by day. It is estimated that this fog signal can be established for not exceeding $5,500, and it is recommended that an appropriation of this amount be made therefor.

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—. *Superior Bay Lights, Wisconsin.*—An appropriation of $1,200, was made by the act approved August 5, 1892, for establishing post lights from Superior Bay entrance to Conners Point. The lights, twenty in number, were put in operation on June 15 and 16, 1893.

1252. Grand Marais, Lake Superior, Minnesota.—A keeper's dwelling is needed at this station, but there is no land here belonging to the Government on which to build. There is an unexpended balance in the Treasury of $8,409.17 remaining of the appropriation made by act of March 3, 1885, "for completing the construction of a light-house at Grand Marais, Minn.," but the rulings of the accounting officers of the Treasury Department are such that this can not be used for the purchase of a site and erection of a keeper's dwelling. The land can be purchased and a suitable dwelling erected at an estimated cost not to exceed $8,400, and it is recommended that Congressional authority be obtained for using the balance of the above appropriation for this purpose.

—. *Hat or Pats Point, near Grand Portage, Lake Superior, Minnesota.*—The establishment of a light and fog signal here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

REPAIRS.

Repairs, more or less extensive, were made during the year at the following-named stations:

1113. Belle Isle, Mich.
1114, 1115. Windmill Point Range, Mich.
1116. Windmill Point, Mich.
1123–1136. St. Clair River Lights, Mich.
1137. Fort Gratiot, Mich.
1139. Sand Beach, E. entrance, N. (main) light, Mich.
1143. Pointe aux Barques, Mich.
1144. Port Austin Reef, Mich.
1147. Charity Island, Mich.
1148. Tawas, Mich.
1150. Sturgeon Point, Mich.
1151. Alpena, Mich.
1152. Thunder Bay Island, Mich.
1153, 1154. Presque Isle Harbor Range, Mich.
1155. Presque Isle, Mich.
1156. Spectacle Reef, Mich.
1157. Detour, Mich.
1160. Cheboygan Crib, Mich.
1205. St. Marys Falls Canal, north pier, Mich.
1211. Point Iroquois, Mich.
1212. Whitefish Point, Mich.
1213. Big Sable, Mich.
1215. Grand Island Harbor, Mich.
1218. Marquette, Mich.
1219. Marquette Breakwater, Mich.
1220. Granite Island, Mich.
1221. Huron Island, Mich.
1222. Stannard Rock, Mich.
1223. Sand Point, Mich.
1227. Manitou, Mich.
1231. Copper Harbor Range, rear, Mich.
1232. Eagle Harbor, Mich.
1239. Ontonagon, Mich.
1241. Outer Island, Wis.
1242. Michigan Island, Wis.
1243. La Pointe, Wis.
1244. Raspberry Island, Wis.
1246. Sand Island, Wis.
1249. Duluth Range, front, Minn.
1251. Two Harbors, Minn.
1253. Isle Royale, Mich.
1254. Passage Island, Mich.

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GENERAL PURPOSES.

Pipe cutting tools to enable the keepers to make repairs when necessary to the fog-signal stations were delivered by the tender *Marigold* at Fort Gratiot, Sand Beach, Port Austin Reef, Thunder Bay Island, Spectacle Reef, Point Iroquois, Marquette, Huron Island, Stannard Rock, Manitou Island, Outer Island, La Pointe, Devils Island, Two Harbors, and Passage Island light-stations. A machine for curving rails for hand railing for tower stairs was purchased. This is to be used in providing the many high towers in the lake districts with hand railings.

OIL HOUSES.

Pointe aux Barques, Sturgeon Point, Point Iroquois, and Whitefish Point light-stations were provided with oil houses.

LIGHT-SHIPS.

1118. Grossepoint light-vessel, No. 10, Lake St. Clair, Michigan.—This vessel is in good order.

—. *Lake Huron light-vessel, No. 61, at the foot of Lake Huron, Michigan.*—By the sundry civil appropriation act, approved August 5, 1892, it was provided that—

> The appropriation of $60,000 heretofore made in the act approved August 30, 1890, for establishing a light-station on or near Eleven-Foot Shoal, off Point Peninsula, Michigan, be applied, under the direction of the Light-House Board, for the construction or purchase and equipment of one or more light-ships for service on the Great Lakes, and that said appropriation be immediately available for such ships.

The Board arranged to build three light-vessels from this appropriation. It was concluded, after much consultation and careful deliberation, to establish one light-vessel so as to mark the shoal spot of 11 feet to the northward and westward of the Northwest Shoal, at the foot of Lake Huron. It will be a definite guide for vessels bound up or down in clearing the shoal places in the vicinity by keeping to the westward and close aboard of the light-ship. Contract was made for building this light-vessel at Toledo, Ohio. It was dated March 29, 1893, and it required that the light-vessel be delivered in four calendar months from that date, which makes her due on July 29, 1893. She is to be built of wood, 80 feet 9 inches long, 21 feet 6 inches beam, and 9 feet 5 inches depth of hold, with a displacement of about 195 tons. She is to have a 6-inch steam whistle as a fog signal, actuated by a Warrington water-tube boiler able to get up steam sufficient to commence signaling in 15 minutes from the time its fire is lighted. The characteristic of her fog signal will be a blast of two seconds and a silent interval of ten seconds, repeated during the fog. Her hull is to be

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painted straw color with the legend "LAKE HURON" in black letters from 18 to 24 inches high on each side, and her number, 61, in black figures on her quarter. Her day mark is to consist of black cagework at each masthead. She is to have at night a cluster of three lights at the masthead showing around 240 degrees of the horizon. It is expected that she will be placed on her station early in the autumn.*

—. *Poe Reef light-vessel, No. 62, Straits of Mackinac, Michigan.*—By the sundry civil appropriation act, approved August 5, 1892, it was provided that—

The appropriation of $60,000, heretofore made in the act approved August 30, 1890, for establishing a light-station on or near Eleven-Foot Shoal, off Point Peninsula, Michigan, be applied, under the direction of the Light-House Board, for the construction or purchase and equipment of one or more light-ships for service on the Great Lakes, and that said appropriation be immediately available for such ships.

The Board arranged to build three light-vessels from this appropriation. It was concluded, after much consultation and careful deliberation, to establish one light-vessel so as to mark Poe Reef. This reef is at the entrance of the Straits of Mackinac, off the southeast end of Bois Blanc Island. The combined tonnage from Green Bay and the rest of Lake Michigan passes this reef on its way to the lower lakes. Contract was made for building this light-vessel at Toledo, Ohio. It was dated March 29, 1893, and it required that the light-vessel be delivered in four calendar months from that date, which makes her due on July 29, 1893. She is to be built of wood, 80 feet 9 inches long, 21 feet 6 inches beam, and 9 feet 5 inches depth of hold, and is to have a displacement of about 195 tons. She is to have a 6-inch steam whistle as a fog signal, actuated by a Warrington water-tube boiler able to get up steam sufficient to commence signaling in fifteen minutes from the time its fire is lighted. The characteristic of her fog signal is to be a blast of five seconds, followed by silent intervals of ten seconds, repeated during the fog. Her hull is to be painted red, with the legend "POE REEF" in white letters from 18 to 24 inches high on each side, and her number, 62, is to be painted in white figures on each quarter. Her day mark is to consist of red cagework at her foremast head. She is to have at night a cluster of three lights at the masthead showing around 240° of the horizon. It is expected that she will be placed on her station early in the autumn.†

The establishment of a light-ship on this station, at a cost not to exceed $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated. And it will maintain one of the cheaply-built light-ships on this station pending the appro-

*This light-vessel was placed on her station on September 25, 1893.

†This light-vessel was placed on her station on September 29, 1893.

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priation of the sum authorized for building a more permanent and suitable vessel for the station.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

1137. Fort Gratiot, Michigan.—This 8-inch steam whistle was in operation some 124 hours, consuming about 12¼ tons of coal.

1139. Sand Beach (Harbor of Refuge), north main light, Michigan.—The 10-inch steam whistle was in operation some 157 hours, consuming about 20 tons of coal.

1144. Port Austin Reef, Michigan.—The first-class steam siren was in operation some 83 hours, consuming about 9 tons of coal.

1152. Thunder Bay Island, Michigan.—This 10-inch steam whistle was in operation some 189 hours, consuming about 15 tons of coal.

1155. Presque Isle, Michigan.—This steam whistle was in operation some 360 hours, consuming about 27 tons of coal.

1156. Spectacle Reef Michigan.—This 10-inch steam whistle was in operation some 154 hours, consuming about 8 tons of coal.

1157. Detour, Michigan.—This 10-inch steam whistle was in operation some 222 hours, consuming about 13½ tons of coal.

1159. Cheboygan, Michigan.—This 10-inch steam whistle was in operation some 196 hours, consuming about 18 tons of coal.

1211. Point Iroquois, Michigan.—This 10-inch steam whistle was in operation some 414 hours, consuming about 25½ tons of coal.

1212. Whitefish Point, Michigan.—This 10-inch steam whistle was in operation some 340 hours, consuming about 22 tons of coal.

1218. Marquette, Michgan.—This 10-inch steam whistle was in operation some 206 hours, consuming about 11 tons of coal.

1221. Huron Island, Michigan.—This 10-inch steam whistle was in operation some 45 hours, consuming about 4 tons of coal.

1222. Standard Rock, Michigan.—This 10-inch steam whistle was in operation some 144 hours, consuming about 9½ tons of coal.

1227. Manitou, Michigan.—This 10-inch steam whistle was in operation some 360 hours, consuming about 28 tons of coal.

1241. Outer Island, Wisconsin.—This 10 inch steam whistle was in operation some 70 hours, consuming about 9 tons of coal.

1243. La Pointe, Wisconsin.—This 10-inch steam whistle was in operation some 240 hours, consuming about 19 tons of coal.

1245. Devils Island, Wisconsin.—This 10-inch steam whistle was in operation some 259 hours, consuming about 13½ tons of coal.

1249. Duluth (front range), Minnesota.—This 10-inch steam whistle was in operation some 334 hours, consuming about 21 tons of coal.

1251. Two Harbors, Minnesota.—This 10-inch steam whistle was in operation some 334 hours, consuming about 33 tons of coal.

1254. Passage Island, Michigan.—This 10-inch steam whistle was in operation some 282 hours, consuming about 21 tons of coal.

Eleventh District.

BUOYAGE.

There are in the district 158 buoys in position, classified as follows:

Iron bell buoys	2
Iron can buoys—	
First-class	2
Second-class	2
Third-class	3
Iron nun buoys—	
First-class	1
Second-class	6
Cedar spar buoys—	
Second-class	80
Third-class	57
Total	158

The buoyage of the district was increased by 3 spar buoys placed in the St. Marys River. The third-class can, marking Scammons Cove, Lake Huron, was discontinued on the opening of navigation, 1893.

There were no complaints during the past year as to the buoy service of the district. Rafts have been giving trouble in Saginaw River, carrying away buoys into deep water, where they are lost. Owing to the services of the patrol steamer in the St. Marys River, as soon as a raft removed a buoy it was immediately replaced, causing no detention to vessels passing up or down the river.

DEPOTS.

Detroit, Mich.—Mount Elliott avenue, a comparatively narrow street, leads from Jefferson avenue to the water front, past the marine hospital grounds, and the grounds of the light-house depot. For convenience of shipment and temporary storage it is necessary that materials purchased for light-house constructions be delivered on the light-house grounds, and from time to time considerable delay and difficulty has occurred in consequence of the bad condition of Mount Elliott avenue. It is unpaved, while the hauling to and fro is considerable, the vicinity of the light-house depot being occupied by factories, foundries, and other industrial institutions of considerable magnitude, with lumber yards on the wharves.

Inquiries have been made of the city authorities with reference to the cost of having the street paved from Jefferson avenue to the limit of the light-house holding. Under the city ordinance the original paving of a street is at the cost of the adjacent property owners, divided pro rata according to the extent of their holding. The board of public works has immediate jurisdiction over these matters, and has reached the preliminary decision that the street, if paved, should be paved with brick or concrete. The width of the street is 24 feet, and the cost of paving in front of the light-house grounds with this material would be $960, and for the frontage of the marine hospital grounds $2,600, and

the expense being divided between the fronting proprietors, the cost to the Light House Service and the Marine Hospital Service, respectively, would be one-half of these amounts.

As in the opinion of the Solicitor of the Treasury a special act of Congress authorizing the work is necessary, it is recommended that an appropriation of $2,000 be made, which is sufficient to cover the expense of the entire frontage of both the light-house and the marine hospital grounds.

TENDERS.

The Marigold.—This steamer is in good condition, and was constantly and usefully employed during the season of navigation on inspection trips, supplying light-stations and delivering the fuel and rations allowed to light-keepers. In doing this work she traversed about 10,794 miles, and consumed some 563 gross tons of coal.

The Warrington.—This steamer was employed on the St. Marys River during the season of 1892 in locating cribs, locating and running ranges, transferring workmen and material from station to station, and assisting in the measurement of ranges, in delivering materials to Round Island, and attending the working party at that station; also transferring men and materials for the erection of small lamp houses for range lights, St. Marys River, and in inspecting the upper and lower St. Clair Flats Canal light-stations. She was docked and examined and minor repairs were made. She was laid up for the season at the end of November, and all of the officers and crew were discharged, except the first mate and the engineer. She is still out of commission.

The Lotus.—This steam launch was used in building Round Island light-station, on St. Marys River, and again on work connected with lantern houses at St. Clair River range lights. Her boiler is old, and she should be provided with a new one in preference to making repairs to the old boiler; the engine is very small and nearly worn out. The launch is well worth fitting with both a new boiler and a new engine, as her services are invaluable in connection with the river work.

The Amaranth.—This steamer was employed during the season of 1892 in delivering oil houses and the material for their erection at Sturgeon Point, Pointe aux Barques, Point Iroquois, and Whitefish Point, and material for repairs at Presque Isle Harbor ranges, Presque Isle and Detour light-stations, and material for Round Island and Sweets Point, St. Marys River, establishing Harwood Point ranges, and in attending a working party at Grossepoint beacon, the crew of the tender assisting in the work. She was placed in winter quarters at the Detroit light-house depot wharf in December. During the month a carpenter was employed making repairs on

the tender. During March certain other repairs and alterations were made.

During the year a new set of grate bars was provided for the boilers, the bridge wall was rebuilt, and the lining of fire brick renewed back and front. The machinery was overhauled, the piston rings of the engine were refitted, and a worn out injector was replaced with a new one. The signal lights on the tender were fitted and wired for electric lighting.

She was put in commission in May, 1893, and was employed in delivering material for repairs at St. Clair Flats Range, Spectacle Reef, Detour, Whitefish Point, Grand Island Harbor, Granite Island, Huron Island, Ontonagon, Michigan Island, Outer Island, La Pointe and Raspberry Island, and in landing material for repairs and improvements at Two Harbors, Eagle Harbor, Grand Marais, Isle Royale, Passage Island, Huron Island, Sand Point and Port Sanilac, and brought surplus material from Two Harbors, Devils Island, and Fort Gratiot light-stations to Detroit. During her first trip to Lake Superior the steamer broke her propeller wheel. She was docked on the 15th, and the broken wheel replaced with a new one. She steamed in the Eleventh Light-House District about 6,233 miles, and consumed some 517 tons of coal, which, together with her work in the ninth district, makes a total mileage of 8,336, and coal consumption of 692 tons, while in actual service, during season of navigation. Some 125 additional tons of coal were consumed while in winter quarters, keeping steam for protection of the property at the light-house depot, Detroit, Mich.

TWELFTH DISTRICT.

This district extends from the boundary line between California and Mexico to the boundary between California and Oregon, a distance of about 800 miles of coast line, and embraces all the aids to navigation on the seacoast, bays, and navigable rivers of California.

Inspector.—Commander Thomas Perry, U. S. Navy, to December 31, 1892; from that time, Commander Henry E. Nichols, U. S. Navy.

Engineer.—Maj. William H. Heuer, Corps of Engineers, U. S. Army.

There are in this district:

Light-houses and lighted beacons, including 3 post lights	39
Day or unlighted beacons	55
Fog signals operated by steam	15
Fog signals operated by clockwork	8
Fog signal operated by hand	1
Whistling buoys in position	12
Bell buoys in position	5
Other buoys in position	78
Steamer *Madroño*, buoy tender, and for supply and inspection	1
Steam launch of *Madroño*	1
Steam launch *Hazel*	1

The aids to navigation in the Twelfth Light-House District on July 1, 1893, are classified as follows:

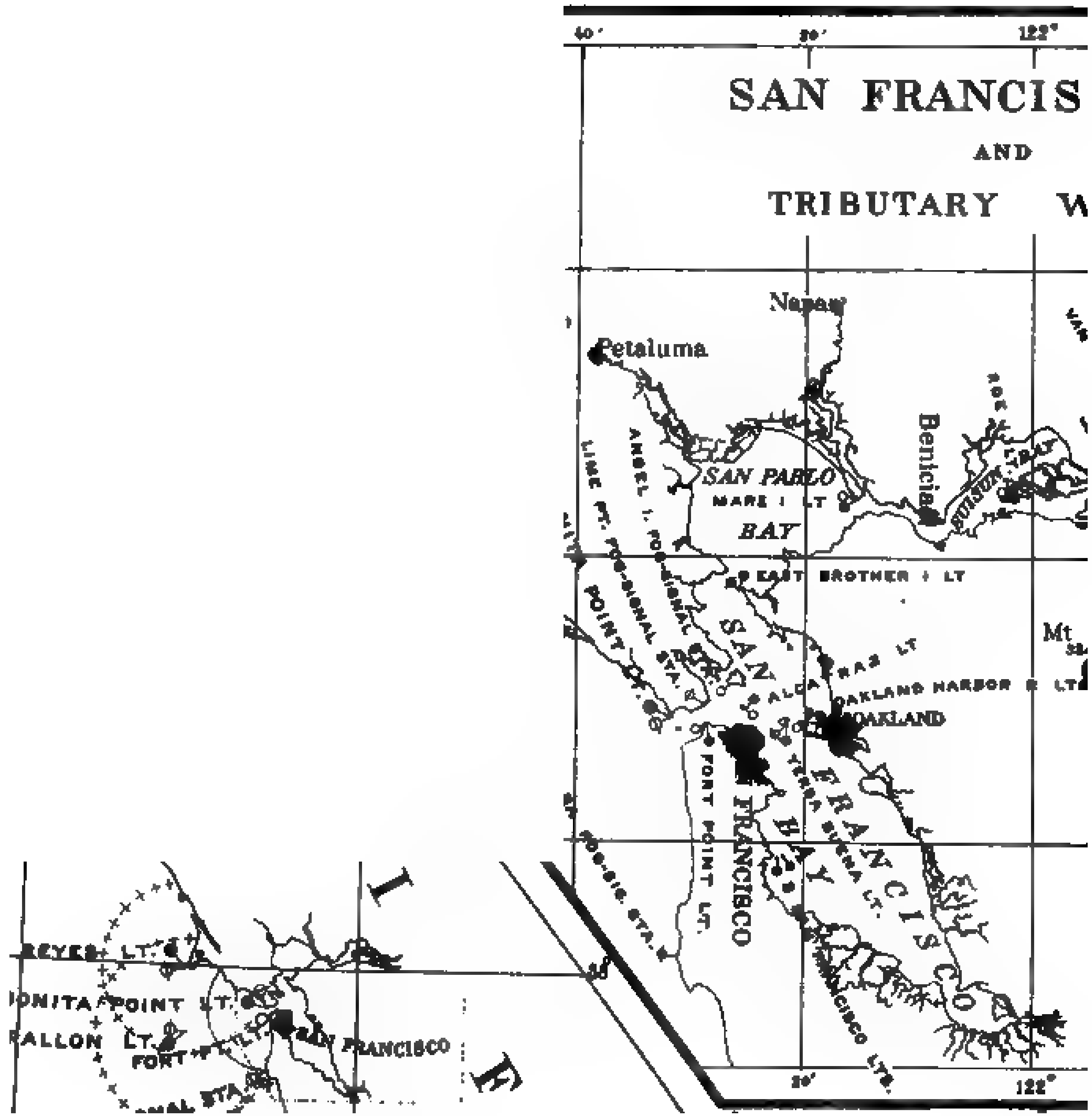
First-order lights	9
Second-order light	1
Third-order lights	3
Fourth-order lights	10
Fifth-order lights	5
Lens lanterns	4
Tubular lanterns	7
Total	39

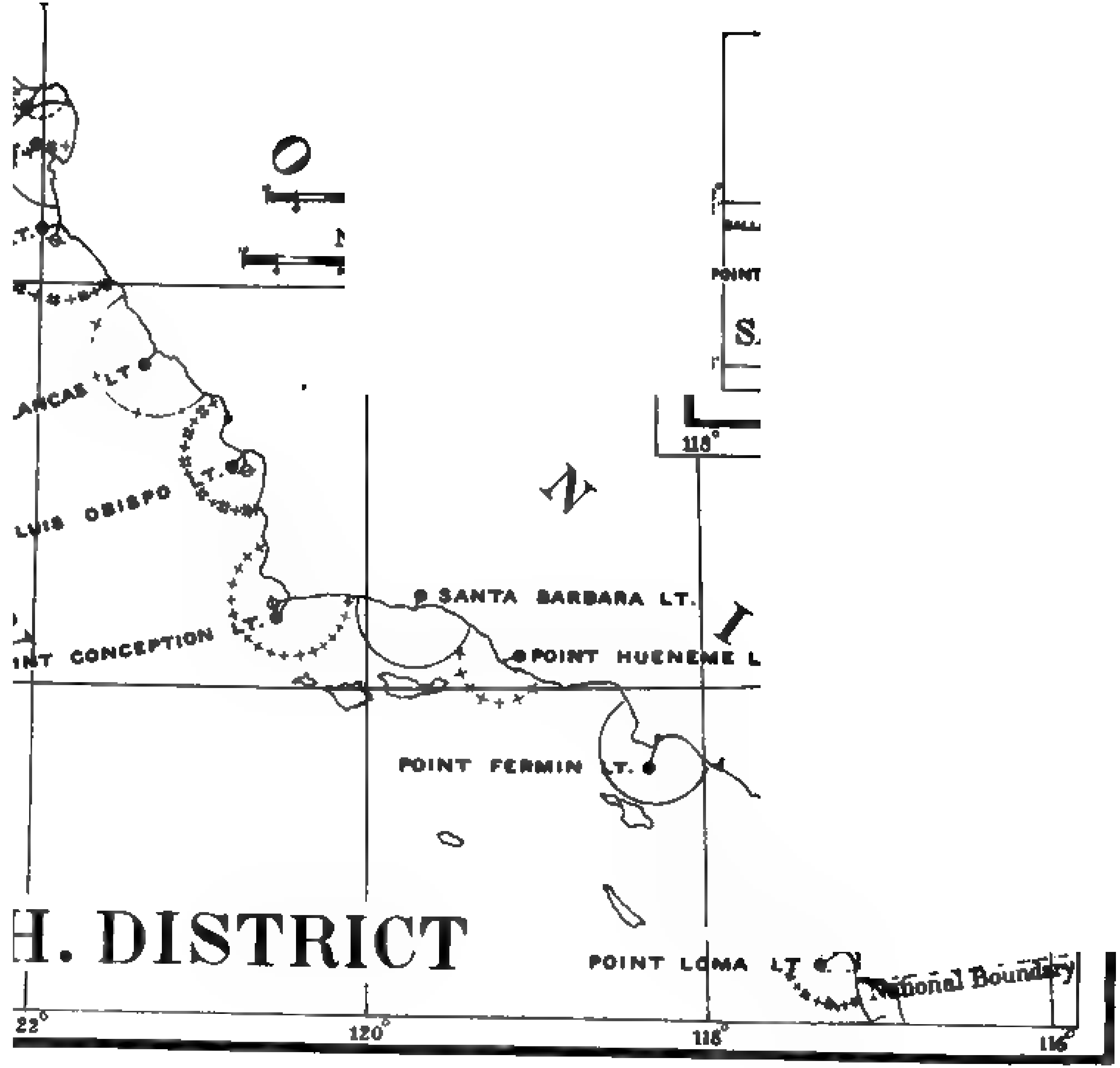
LIGHT-HOUSES.

847. Point Loma, entrance to San Diego Bay, California.—Fences were built and minor repairs were made.

848. Ballast Point, San Diego Bay, California.—A new wharf was built out to water 10 feet deep. The fog-bell apparatus was repaired.

854. Point Hueneme, entrance to Santa Barbara Channel, California.—The efforts made last year to secure the right of way to and from this station being unsuccessful on account of the exorbitant price asked for the land by the owners, it was decided to obtain title by condemnation. The principal item of expense appears to be the excessive cost


SAN FRANCIS
AND
TRIBUTARY W
Napa
Petaluma
Benicia
SAN PABLO
MARE I. LT.
BAY
EAST BROTHER I. LT.
ANGEL I. FOG-SIGNAL STA.
LIME PT. FOG-SIGNAL STA.
POINT LT.
SAN FRANCISCO BAY
ALCATRAZ LT.
OAKLAND HARBOR LT.
OAKLAND
YERBA BUENA LT.
SAN FRANCISCO
FORT POINT LT.
FOG-SIG. STA.
SAN FRANCISCO LTS.
Mt.
REYES LT.
BONITA POINT LT.
FARALLON LT.
FORT PT. LT.
SAN FRANCISCO
40'
30'
122°



O
N
I
S
POINT
SANTA BARBARA LT.
POINT HUENEME L
POINT FERMIN LT.
POINT LOMA LT.
National Boundary
CONCEPTION LT.
LUIS OBISPO
LT.
H. DISTRICT
120°
118°
116°

Twelfth District.

of an abstract of title, for which $2,750 is charged. As the land itself, about 2 acres, is not worth over $125 per acre, or $250 in all, it seems excessive to pay the above-named price for an abstract of title. It is recommended, however, in view of the great need for the road, that an appropriation of $3,000 be made to obtain the abstract of title and to carry on the condemnation suit.

855. *Santa Barbara, on the point 2 miles southeast of Santa Barbara Landing, California.*—The water supply was found to be insufficient, and to remedy this a well, about 50 feet deep, was dug, reaching an ample supply. This well was walled with brick.

—. *Point Arguello, about 12 miles northwest of Point Conception, seacoast of California.*—The following recommendation, which appeared in the Board's annual report for the last four years, is renewed:

This point is about 12 nautical miles to the northward and westward of Point Conception. It is reported to be one of the foggiest places on the Pacific coast. In consequence of the sharp bend in the coast, the outlying rocks, and the almost constant fog that prevails, Point Arguello is one of the most important points on the coast at which a light and fog-signal station should be established. The United States already owns the site which is deemed most suitable for the buildings. It is therefore estimated that the work can be done at a cost not to exceed $35,000, and it is recommended that an appropriation of this amount be made therefor.

857. *San Luis Obispo, near Port Harford, seacoast of California.*—A plank walk was laid from the landing to the station, and various minor repairs were made.

—. *Point Buchon, about 8 miles northwest from Point San Luis Obispo, California.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

This point is in San Luis Obispo County and is 17 miles distant from the town of San Luis Obispo by wagon road and trail. The nearest light-house is Piedras Blancas, about 30 nautical miles to the northward and westward. The point is prominent, and with its outlying rocks is very dangerous to navigators close inshore during a fog, especially as vessels going to and from Port Harford make a sharp turn just off this point. It is estimated that a light-house and fog signal can be erected at this point for $33,000.

860. *Point Pinos, entrance to Monterey Bay, California.*—The following recommendation, which was made in the Board's annual report for the last four years, is renewed:

The plot of land owned by the Government at this station does not touch the sea at any point on its boundary line. For convenience in landing stores and supplies it is essential that the United States should own the strip of land between the light-house lot and the seacoast. The owners have offered to sell the land desired for $2,000, and the Board recommends that an appropriation be made for its purchase.

865. *Farallon, on southeast Farallon Islet, Pacific Ocean, off the entrance to San Francisco Bay, California.*—The derrick was replaced. The old landing wharf was torn down and a new one was built. A hoisting engine and boiler were erected on a brick foundation. A sub-

Twelfth District.

stantial house was built over them. The oil house and the engine house are connected with an iron tank for the storage of water for the hoisting boiler. Various repairs were made.

866. *Bonita Point, entrance to San Francisco Bay, California.*—The bridges over the gulches, along the line of the trail from the light-house and signal to the dwellings, were rebuilt. Various repairs were made.

867. *Lime Point, San Francisco Bay, California.*—The trail along the hillside leading from the station to the nearest town, Sausalito, was carried away by a heavy storm and landslides. It was rebuilt on a new location for three-fourths of a mile. Two truss bridges spanning gulches 50 and 54 feet wide and a trestle 120 feet long by 22 feet in height were built.

—. *Quarry Point, Angel Island, San Francisco Bay, California.*—The following recommendation, made in the Board's last annual report, is renewed:

Various petitions were received from those representing marine interests asking that a fog signal be established at this point. The passage between the eastern side of Angel Island and Southampton Shoal is quite narrow. The strong tides setting in and out through the Golden Gate have full force on a vessel bound up or down the bay, and in the case of ships being towed, as so many are past this point, the set of the current is enough to make it hazardous, there being danger either of running aground on Southampton Shoal or Angel Island. An enormous quantity of shipping annually passes this point, bound to and from the great grain wharves at Port Costa, the Sacramento and San Joaquin rivers, and Mare Island Strait. Hundreds of the largest sailing ships are towed from San Francisco to Port Costa, where they load with grain and are then towed down and out to sea. In this way there is more shipping passing through these waters than anywhere else in the district except through the Golden Gate. There have been a number of casualties in the vicinity of this point. Among many were the following:

The ferry steamer *Contra Costa*, plying between San Francisco and San Quentin with passengers, ran ashore near California City.

The ship *E. B. Sutton*, while being towed down from Port Costa, ran ashore near Quarry Point, Angel Island.

The ship *Eleanor Margaret*, bound to Port Costa, ran ashore on Bluff Point, Raccoon Straits.

The ship *Maulsden*, while being towed to Port Costa, ran ashore on Southampton Shoal.

Mariners have asked that Quarry Point be selected for the fog-signal station, because, to make a start up river in a fog, it is necessary to make Angel Island to get a departure. After careful examination the Board reached the conclusion that a fog signal at this locality would be a decided aid to mariners. In view of the great economy of establishing and maintaining a large fog bell here instead of a steam fog signal, it decided in favor of the former. It is estimated that it will cost $6,000 to establish this fog bell, and it is recommended that an appropriation of this amount be made therefor.

872, 873. *Oakland Harbor, entrance to Oakland Harbor, California.*—The Board decided to dispense with the inner red light, situated just outside the north training wall, about three-fourths of a mile to the eastward of the outer white light, and to establish instead a red

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light on the southern side of the entrance, in the prolongation of the south jetty, about 240 feet outside its outer end. The beacon consists of 4 piles standing in 13 feet of water at low tide, surmounted by a square structure about 7 feet wide by 7 feet high. This is covered with galvanized iron and is painted red. From the top of the beacon a red light will be shown from an 8-day lens lantern. The beacon will be ready for lighting at any time after the lantern is received.

874, 875. San Bruno Channel Beacon Lights, San Francisco Bay, California.—Two beacons lighted with lens lantern, white lights, were established to mark this channel. The work was done under the supervision of the light-house inspector, at the expense of parties interested in improvements in this vicinity. The lights are maintained by the United States. These beacons are a great convenience to the large commerce using this channel in passing to and fro between San Francisco and South San Francisco.

877. Mare Island, entrance to Karquinez Straits, California.—During the high tides of this spring, the waves, driven by a high wind, surmounted and cut in behind the wall at the shore end of the wharf, cutting out the wall for a long distance and undermining the fog bell house, which stood just inside the wall. The damage was repaired by building a new wall containing 70 cubic yards of rubble masonry laid in cement mortar. The old bell-house was taken down; the bell was removed to the outer end of the wharf where a house was built to cover it. A tramway about 200 feet long was built from the wharf up the hill to the dwelling. A new floor was laid in the kitchen and repairs were made to the front porch.

—. New York Slough, entrance to San Joaquin River, California.—The establishment of a light and fog signal here, at a cost not exceeding $10,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. Bodega Head, between Point Arena and Point Reyes light-stations, seacoast of California.—The following recommendation, made in the Board's last four annual reports, is renewed:

It is recommended that a fog-signal station be established at Bodega Head, coast of California, a point 18½ miles to the northward of Point Reyes and 49 miles to the southward of Point Arena. The stretch of coast between Point Reyes and Bodega Head is the scene of many wrecks, due to foggy weather and uncertain currents. Vessels coming down from the north, bound to San Francisco, pass close enough to Point Arena to either see the light or to hear the fog signal there and take a new departure for Point Reyes. The coast line is generally straight as far down as Bodega Head; a fog-signal station at this point would give sufficient warning to vessels which have unconsciously got in there to enable them to haul out in time to weather Point Reyes. It would be a great aid to vessels going into Bodega and Tomales bays, as well as to those going into the landings and lumber chutes immediately above Bodega. Owing to the configuration of the land and other causes, it is

Twelfth District.

extremely difficult to hear the Point Reyes signal anywhere to the northward of the point. Fog, accompanied by northwest winds, varying from fresh to strong in force, prevails above Point Reyes during about nine months of the year. The currents are uncertain in direction either up or down the coast, and seem to be due to causes which exist far to the north. It has been noticed that indrafts prevail off the indentations in the coast, and the current close inshore runs in an opposite direction to what it does outside the headlands. The water is usually so deep in the regular routes up and down the coast that little, if any, use is made of the hand lead. A fog signal at this locality would therefore be of great benefit to mariners, and a small light would also be of much service, at little additional expense, as there is a stretch of unlighted territory about 68 miles in length between Point Reyes and Point Arena. The Government owns no land at Bodega; but 2 or 3 acres would be sufficient for the station, and could probably be bought for $1,000. An engine house, such as is being constructed at San Luis Obispo, with duplicate steam fog-signal whistles, and two single dwellings for the keepers, one to have a tower for the light, as at San Luis Obispo, the other for the assistant keeper, similar to the new one designed for Point Loma light-station, with coal shed, oil house, outhouses, etc., will probably suffice to establish the station. These, it is estimated, will cost $30,000, and it is recommended that an appropriation of this amount be made therefor.

883. *Point Arena, near northwest extremity of Point Arena, California.*—The windmill pump, supplying the station with water, entirely gave out. A new one was purchased and erected in its place.

884. *Cape Mendocino, on the western extremity of Cape Mendocino, California.*—The chimneys on the south side were torn down to 3 feet below the roof and rebuilt to the proper height. An appropriation of $500 was made, in the sundry civil appropriation act, approved August 5, 1892, for the purchase of the right of way for a road to this station, but it is insufficient for the purpose, as the cost of establishing the road is estimated to be $1,000. It is, therefore, recommended that a further appropriation of $500 be made.

—. *Punta Gorda, between Shelter Cove and Cape Mendocino, seacoast of California.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

Between Shelter Cove and Punta Gorda there are several dangerous sunken rocks off the shore that add to the hazards of navigation. In ordinary dark nights the overhanging mountains keep the shore line in dark shadow and confuse the best navigator as to his distance from shore, so that it is impossible to make out this high rounding point, either from the south or from the north. Moreover, from reports made to the Coast and Geodetic Survey, it appears that little is known as to the currents of this part of the coast. The conclusion is reached, therefore, that the interests of commerce and navigation require that a light and fog signal be established at or near Punta Gorda, Cal. It is estimated that the work will cost $40,000.

The British steamer *Bawnmore* struck on a rock at Punta Gorda during a fog and sunk. She is now being pumped out and will be saved. This could not have happened had there been a fog signal at this point.

885. *Humboldt, near the western edge of Table Bluff, entrance to Humboldt Bay, California.*—The reëstablishment of this station on the new site at Table Bluff, commenced last year, was continued until October

Twelfth District.

5, 1892, when it was satisfactorily completed. The lens and one fog-signal boiler were kept at the old station until October 31, the date set for starting the new station. On October 31, the light was exhibited from the new station and the old station was abandoned. The new station on Table Bluff consists of a keeper's dwelling and tower combined, a double dwelling for the assistant keepers, a fog-signal building containing two boilers and engines and a coal shed. The water supply is taken from a spring near the station and is forced into the tanks by a windmill and pump, which are supplemented in times of calm by a hydraulic ram. The reservation of about 10 acres was inclosed by a fence.

888. St. George Reef, Pacific Ocean, on Northwest Seal Rock, St. George Reef, California.—This station was completed last year, except the lens, which had not then been received. During July the lens reached San Francisco, and in August it was taken by the light-house tender to the station, where it was erected. The light is of the first order, flashing alternately red and white, with fifteen seconds interval between flashes, illuminating the entire horizon. It was exhibited for the first time on October 20, 1892. The hoisting engine, left on the rock for use in landing supplies, proved inadequate to the work and finally broke down.

As it was used during the period of construction, its condition and age did not warrant repairs. It was replaced with a new double drum hoisting engine and boiler, which were erected on the top of the pier, and a small house was built over them for protection from the weather. In September the signal was temporarily discontinued on account of lack of water, but by the end of the month a fall of rain gave an ample supply and the signal was again put in operation.*

REPAIRS.

During the fiscal year, repairs and renovations, more or less extensive, were made at the following-named stations:

858. Piedras Blancas, Cal.
859. Point Sur, Cal.
860. Point Pinos, Cal.
861. Santa Cruz, Cal.
862. Año Nuevo Island, Cal.
863. Pigeon Point, Cal.
864. Point Montara, Cal.
870. Alcatraz Island, Cal.
871. Yerba Buena Island, Cal.
878. Roe Island, Cal.
882. Point Reyes, Cal.
886. Trindad Head, Cal.
887. Crescent City, Cal.

DAY OR UNLIGHTED BEACONS.

The day beacons of this district were cared for during the year.

Two of the three piles of Berkeley beacon having been carried away by the winter gales, it was rebuilt as a single pile beacon.

*On July 22, 1893, an easy landing was made on the rock. The entire station was found to be in excellent condition. It is now amply provided with coal and supplies.

Twelfth District.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

856. *Point Conception, California.*—The 12-inch steam whistles, in duplicate, were in operation some 244 hours and consumed about 26 tons of coal.

857. *San Luis Obispo, California.*—The 10-inch steam whistles, in duplicate, were in operation some 1,166 hours and consumed about 69 tons of coal.

859. *Point Sur, California.*—The 12-inch steam whistles, in duplicate, were in operation some 855 hours and consumed about 89 cords of wood.

862. *Año Nuevo Island, California.*—The 12-inch steam whistles, in duplicate, were in operation some 602 hours and consumed about 38 tons of coal.

863. *Pigeon Point, California.*—This signal, consisting of one 10-inch and one 12-inch steam whistle, was in operation some 698 hours and consumed about 68 cords of wood.

864. *Point Montara, California.*—The 12-inch steam whistles, in duplicate. were in operation some 531 hours and consumed about 63 cords of wood.

865. *Farallon, California.*—The first-class steam siren, in duplicate, was in operation some 872 hours and consumed about 56 tons of coal.

866. *Bonita Point, California.*—The first-class steam siren, in duplicate, was in operation some 1,168 hours, and consumed about 96 tons of coal.

867. *Lime Point, California.*—The 12-inch steam whistles, in duplicate, were in operation some 700 hours, and consumed about 73 tons of coal.

871. *Yerba Buena Island, California.*—The 10-inch steam whistles, in duplicate, were in operation some 159 hours, and consumed about 9 tons of coal.

876. *East Brother Island, California.*—The 12-inch steam whistle was in operation some 161 hours, and consumed about 13 tons of coal.

882. *Point Reyes, California.*—The 12-inch steam whistle, in duplicate, was in operation some 1,382 hours, and consumed about 89 tons of coal.

883. *Point Arena, California.*—This signal, consisting of one 10-inch and one 12-inch steam whistle, was in operation some 1,043 hours, and consumed about 118 cords of wood.

885. *Humboldt, California.*—This signal, consisting of one 10-inch and one 12-inch steam whistle, was in operation until October 31, 1892, at the old station on the north side of the entrance to Humboldt Bay, some 348 hours, and consumed about 31 cords of wood; and since that date, was in operation at the new station on Table Bluff some 248 hours, and consumed about 25 cords of wood.

Twelfth District.

888. *St. George Reef, California.*—The 12-inch steam whistle, in duplicate, was in operation some 405 hours, and consumed about 27 tons of coal.

BUOYAGE.

The buoyage is in excellent condition. All buoys are in place except Tongue Shoal buoy, at the mouth of Sacramento River. Much trouble was had in keeping this buoy in place. It will be recovered and replaced at an early date. Work on the north jetty at Humboldt Bay is in progress. It is reported that the old channel is beginning to cut out again; should this channel cut entirely through it is probable that the new or Bucksport Channel will fill up. In that case the beacons placed there last year will be of no further use, and a rebuoyage of the channel will be necessary. The Board, on December 3, 1892, directed the placing of six beacons to mark the channel of Mad River; they were placed by contract. Five fourth-class spar buoys, were placed in position on September 21, 1892, to mark the entrance to Alviso Channel at the head of San Francisco Bay. The red and black horizontal striped buoy marking the outer junction of the old and Bucksport channels, Humboldt Bay, was changed to Black No. 3. As the old channel had closed, the numbers of the Bucksport channel beacons were also changed to preserve the proper sequence of numbers after Buoy No. 3. The third-class red and black horizontal striped spar buoy at the junction of Suisun and Montezuma creeks, Suisun Bay, was discontinued being of no further use to navigation. The second-class spar buoy painted green, marking the wreck of the *Autocrat*, about 200 yards to the westward of Alcatraz Island, San Francisco Bay, was discontinued as the wreck has entirely disappeared.

WHISTLING BUOYS IN POSITION.

San Diego Bar, California.—A second-class whistling buoy, in good condition.

Point Arguello, California.—A second-class whistling buoy, in good condition.

Point Buchon, California.—A second-class whistling buoy. The whistle was reported as not working well; it will be changed as soon as possible.

Piedras Blancas, California.—A second-class whistling buoy, in good condition.

Point Pinos, California.—A second-class whistling buoy, in good condition.

Santa Cruz, California.—A second-class whistling buoy, in good condition.

San Francisco Bar, California.—A first-class whistling buoy, in good condition.

Twelfth District.

Saunders Reef, California.—A second-class whistling buoy, in good condition.

Fort Bragg Landing, California.—A second-class whistling buoy, in good condition.

Blunts Reef, Cape Mendocino, California.—The first-class whistling buoy at this place was changed on October 27, 1892, to a second-class whistling buoy. It does not work satisfactorily and will soon be changed.

Humboldt Bar, California.—A second-class whistling buoy, in good condition.

Crescent City, California.—A second-class whistling buoy, in good condition.

BELL BUOYS IN POSITION.

San Diego Bar, California.—A first-class bell buoy, in good condition.

San Pedro Bay, California.—A first-class bell buoy, in good condition.

San Luis Obispo Bay, California.—A first-class bell buoy, in good condition.

Noonday Rock, California.—An improved first-class bell buoy, in good condition.

Point Arena, California.—A first-class bell buoy, in good condition. This buoy was placed in position on May 31, 1893.

DEPOT.

Yerba Buena Island, California.—All the buildings were painted and are in a fair state of preservation. The wharf is unsafe. The engineer of the district is at this time making examinations with a view to making temporary repairs. A valuable lot of buoys, chain, sinkers, etc., are stored there. One of the derricks from St. George Reef, now stored at the depot, will be put up by the depot keeper, aided by the *Madroño's* crew.

TENDERS.

The Madroño.—This steamer was employed actively during the year in attending to the buoyage, supply, and inspection of the district. She changed or replaced 84 buoys, painted or repaired 15 beacons, landed some 710 tons of coal at 22 different stations, delivered supplies to 35 stations, and conveyed the inspector to all the stations in the district, except Cape Mendocino and Humboldt, which were visited by other conveyance, making 143 inspections during the year. In doing this work she steamed about 7,989 miles and consumed some 735 tons of bituminous coal. The crew were employed at the depot 983 hours and the vessel was laid up 39 days for repairs to her hull and machinery. She was docked twice during the year to clean and paint the bottom; the hurricane deck was repaired and recanvased; the rudder chains, derrick, and stearing gear were repaired and the plumbing was over-

Twelfth District.

hauled; soft patches were put on the legs, flues, uptake, and furnaces of the boilers; a few leaky socket bolts were renewed; some calking was done; a set of Mailer grate bars was furnished to one boiler; a new smokestack was made and set up; new metallic packings were furnished for the horse-power rod of the main engine; new brass 1¼-inch tubes were put in the feed-water heater; the crank-pin brasses and the check valve of the port boiler were repaired, and a new pinion for the after winch and larger holding-down bolts for the forward winch were furnished. On May 8, 1893, the *Madroño* was docked at the Union Iron Works and her bottom thoroughly cleaned and painted with a mixture of white zinc and red lead, which was found to give good results.

The Madroño's steam launch.—This launch for use at the depot and at harbor stations is run by the depot keeper, having no other crew. She is a valuable acquisition, and can readily do any work required in the bay in moderate weather. She is now hauled up on the ways at the depot and the carpenter of the *Madroño* is putting on her copper. The boat has a cast-iron propeller, and now that she is coppered it is probable that a new composition propeller will soon be necessary. The usual consumption of fuel for the launch is about 2 tons per month.

THIRTEENTH DISTRICT.

This district extends from the southern boundary of Oregon to the boundary line between the United States and British Columbia, and embraces all the aids to navigation on the Pacific coast of Oregon and Washington, and the Columbia and Willamette rivers, Strait of Juan de Fuca, Puget Sound, and Alaskan waters.

Inspector.—Lieut. Commander William W. Rhoades, U. S. Navy, until July 31, 1892; since then, Commander Oscar W. Farenholt, U. S. Navy.

Engineer.—Maj. Thomas H. Handbury, Corps of Engineers, U. S. Army.

There are in this district—

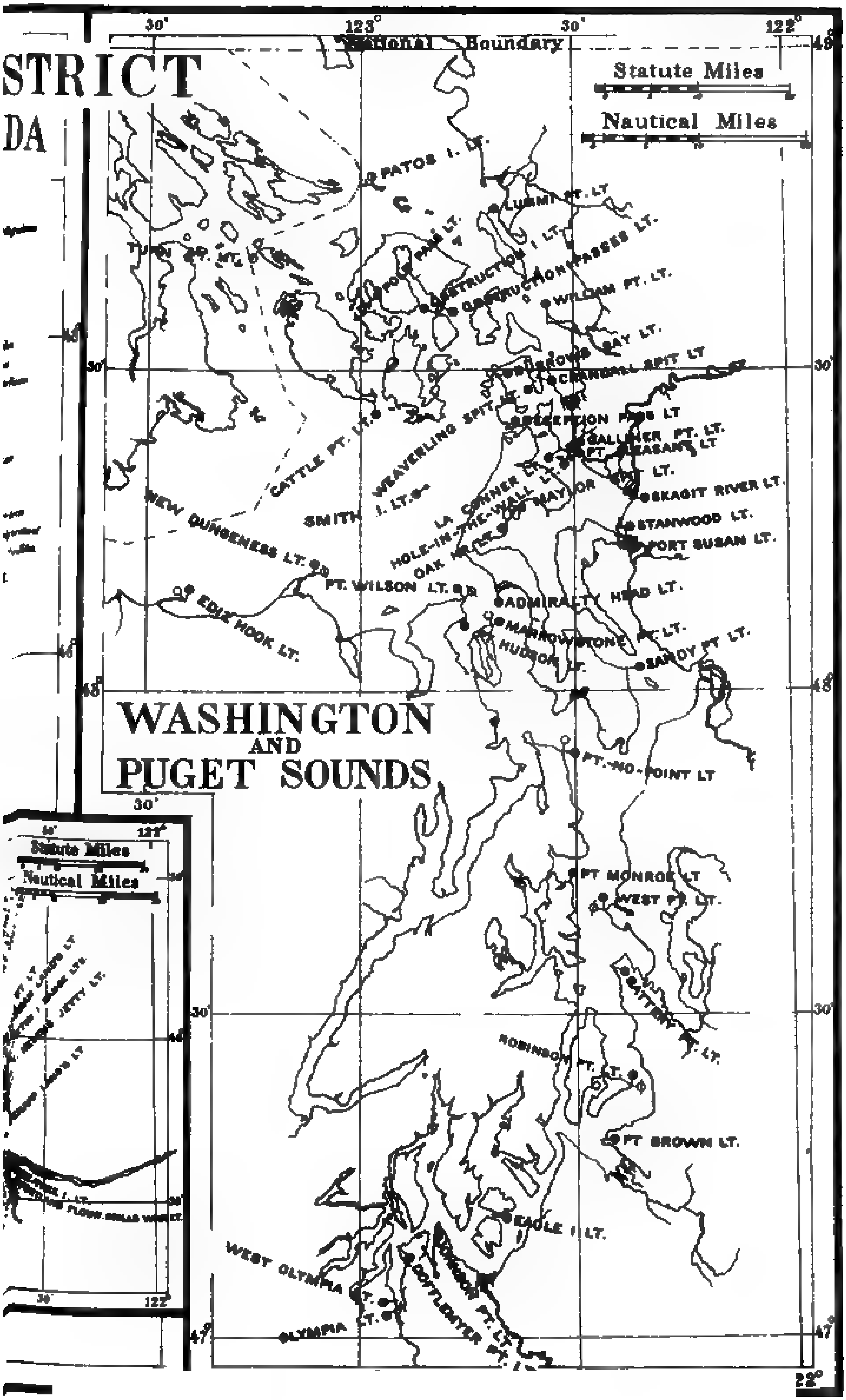
Light-houses and beacon lights, including 80 post lights	97
Light-ships in position	1
Day or unlighted beacons	48
Fog signals operated by steam or hot-air engines	8
Fog signals operated by clockwork	3
Whistling buoys in position	8
Bell buoys in position	4
Other buoys in position	231
Steamer *Manzanita*, buoy tender, and for supply and inspection	1
Steamer *Columbine*, buoy tender, and for supply and inspection	1

LIGHT-HOUSES.

889. Cape Blanco, seacoast of Oregon.—During December, 1892, a number of trees fell across the road leading from the county road to the light-station. These were removed in January, 1893, and communication was reëstablished with the station. A part of this road along the side hill, about three-fourths of a mile from the station, covered with corduroy, has been sliding for some time, until now it has reached a condition where repairs are absolutely necessary. These will be made before the rainy season sets in.

890. Coquille River, at the mouth of Coquille River, seacoast of Oregon.—Negotiations have been in progress for the purchase of the land needed for this station.

891. Cape Arago, on a small island at the western end of Cape Arago, seacoast of Oregon.—The commerce of these waters would be greatly benefited by placing a first-class fog signal on the point of the island on which this light is located. It is estimated that this fog signal can be established for not exceeding $5,500.


STRICT
DA
WASHINGTON
AND
PUGET SOUNDS
National Boundary
Statute Miles
Nautical Miles
PATOS I. LT.
LUMMI PT. LT
OBSTRUCTION PASSES LT.
WILLIAM PT. LT.
CRANDALL SPIT LT
DECEPTION PASS LT
CATTLE PT. LT.
WEAVERLING SPIT
SMITH I. LT.
NEW DUNGENESS LT.
LA CONNER LT.
HOLE-IN-THE-WALL LT.
OAK HARBOR
SKAGIT RIVER LT.
STANWOOD LT.
PORT SUSAN LT.
PT. WILSON LT.
EDIZ HOOK LT.
ADMIRALTY HEAD LT.
MARROWSTONE PT. LT.
SANDY PT LT.
PT.-NO-POINT LT
PT MONROE LT
WEST PT. LT.
ROBINSON PT. LT.
PT BROWN LT.
EAGLE I. LT.
WEST OLYMPIA LT.
OLYMPIA LT.
DOFFLEMYER PT. LT.
Statute Miles
Nautical Miles

Thirteenth District.

The light-keepers' dwelling at this station was erected in 1866. It was poorly built and ill adapted to accommodate the two keepers with their families; it is old and decayed and on the verge of collapse. If a fog signal is erected here, still another keeper will be needed and his family will need quarters. It is estimated that a double set of quarters, similar to those recently erected at Turn Point and Patos Island light-stations, can be built here for not exceeding $10,000.

By the act approved March 3, 1891, $50,000 were appropriated for the establishment of a light and fog signal at the mouth of the Coquille River, Oregon. It is now found that it can be done for a much less sum. It is, therefore, recommended that the Light-House Board be authorized to expend not exceeding $15,500, from the appropriation for establishing a light and fog signal at the mouth of the Coquille River, in erecting light-keepers' dwellings and a fog signal at Cape Arago light-station.

892. Umpqua River, seacoast of Oregon.—The contractor for the erection of the tower at this station completed his work on August 30, 1892. The contractor for the erection of the dwellings, barn, etc., completed his work on January 14, 1893. Since January 19, 1893, the station has been in charge of a watchman. The lens and illuminating apparatus for this tower are at the station. When an attempt was made to put these in place it was found that the stand which supports the lens was not of the proper height and would need the addition of a base to raise the lens about 15 inches. The estimated cost of the work and material absolutely necessary to exhibit the light is $200. The estimated cost of completing the station is not exceeding $2,400. There are no funds available for this work, the whole of the appropriation having been expended. There is pay due the watchman from May 1 to June 30, 1893, at the rate of $60 per month. This financial status results from the failure of the original contractors for the erection of the keepers' dwelling, barn, etc., to carry out their contract of September 17, 1891, which caused the reletting of the work, at additional cost, as set forth in the last annual report. There is now due $2,371 from their bondsmen. The United States Attorney-General has the matter in hand, with the view to the collection of this amount from these bondsmen. Meantime, however, this amount is needed to pay the new contractors. The Board therefore recommends that an appropriation of $2,371 be made with which to finish Umpqua River light-station.

893. Heceta Head, mouth of Siuslaw River, between Cape Arago and Cape Foulweather, seacoast of Oregon.—The contractors for the erection of the dwellings, barn, oil houses, etc., on January 25, 1893, completed their contract. A supplemental contract was made with them for additional excavation, amounting to $3,669.40. The buildings have been in charge of a watchman since January 25, 1893. The contractor for

Thirteenth District.

ion of the tower, on account of the additional excavation that e made for the site of the tower, was delayed in getting his on the ground until the stormy weather set in; but he suc- laying the foundation stonework up to the belt course be- winter storms prevented further work. He is now laying the k and has all of his materials on hand to complete the con-

quina Bay, Oregon.—The following recommendation, made in d's last three annual reports, is renewed:

now have occasion to pass in and out of the bay during the night, and needed to prevent accidents. During a part of the year the mail has to be fore daylight in the morning and after dark at night. The necessities of in this locality are such as to demand the establishment of inexpensive his point. It is estimated that they could be established at a cost of , and it is recommended that an appropriation of that amount be made

ape Meares, south of Tillamook Bay, seacoast of Oregon.—By ongress authority was given to expend $5,000 "from appro- for the construction of a light-house at Cape Meares, Oregon," g a wagon road from the station to Tillamook River. Sealed s were invited, by due advertisement, for the construction of . Two proposals were received, but both, being much in ex- he amount available, were rejected. New proposals will be ed for.*

illamook Rock, 18 miles south of the entrance to the Columbia eacoast of Oregon.—Extensive repairs and much-needed im- nts were made at this station. The old wooden landing plat- s removed and was replaced by one made of concrete. The of the derrick were replaced by new ones, well secured at the top, the topping-lift was renewed with galvanized wire rope, ng was overhauled, and the irons were renewed. The roof of ling was refastened by nailing strips on between the standing nd then covering these strips with galvanized iron securely to the roof; new gutters were put on and the roof was left in dition. Both siren fog signals were overhauled. The hoisting eceived a few small repairs, the cement walk around the dwell repaired, and the oil house was replastered. The landing for raph cable was put in position on the rock. It consists of a feet long, projecting out from the rock and securely held in anchored guys; on the outer end of the boom a gin block is , over which the cable will pass down to the bottom of the uch a distance from the rock as to protect it from chafing. No nity has yet been found for laying this cable.

illamette River light-station, at the mouth of the Willamette

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w proposals being excessive also, it has been ordered that the work be ay labor.

Thirteenth District.

River, Oregon.—The establishment of a light and fog-signal station here, at a cost not exceeding $6,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Willamette River post lights, Oregon.*—The establishment of beacon lights and buoys at 25 different points between the cities of Salem and Portland, Oregon, at a cost not exceeding $5,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

917. *Cape Disappointment, seacoast of Washington.*—The establishment of a first-order light at North Head, at a cost not exceeding $50,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Grays Harbor, seacoast of Washington.*—By act of Congress approved March 3, 1893, an appropriation of $20,000, in addition to the $15,500 previously appropriated, was made to establish a first-order light and fog-signal station; and it was further provided that a contract may be made for this work at a total cost not to exceed $75,000. The location of this station had not been definitely determined at the end of the year. Plans of the necessary structures are being prepared.

The establishment of a light and fog signal here, at a cost not exceeding $75,000, was authorized by the act approved February 15, 1893, while appropriation for but $35,500 therefor has yet been made. The Board recommends that the balance, $39,500, be appropriated for the completion of this work.

950. *Cape Flattery, on Tatoosh Island, entrance to the Strait of Juan de Fuca, Washington.*—A new tubular boiler, inclosed with brick walls, set upon a solid concrete foundation, was put up in the fog-signal building, an engine with suitable gearing was attached to the whistle, and all adjusted so as to give a perfect signal. This boiler with its apparatus makes the duplicate fog signal at this station. The old boiler was repaired, pumps were set up, and the fog signal was left in good order. A new tramway was laid from the hoisting-derrick on the edge of the bluff to the fog signal building, and a substantial turntable was put in place. The derrick, hoisting engine, and engine house received small repairs and were painted. The dwelling received numerous repairs. New pipes were put in for the water supply of the hoisting engine and the old pipes from the dwelling to the cistern were repaired.

The following recommendation, made in the Board's last five annual reports, is renewed:

It was decided that the location of the fog signal ought to be changed to West Island, as it could be heard from the latter point much more distinctly by passing

Thirteenth District.

vessels. This change of location, it is estimated, will cost $17,000, and it is recommended that appropriation be made accordingly.

951. *Ediz Hook, Strait of Juan de Fuca, Washington.*—The Port Angeles Mill and Lumber Company still occupies, illegally, a portion of this reservation. The United States Attorney-General was requested to take the proper steps for the ejectment of these parties.

952. *New Dungeness, Strait of Juan de Fuca, Washington.*—The old boiler of the fog signal was temporarily repaired. A new boiler was purchased, and brick, lime, cement, etc., were delivered at the station to put up a new fog signal. A corrugated-iron oil house was purchased and delivered and will soon be set up.

954. *Point Wilson, Admiralty Inlet, Washington.*—A corrugated-iron oil house was purchased and delivered at the station.

957. *Marrowstone Point post light, Admiralty Inlet, Puget Sound, Washington.*—By act of Congress approved March 3, 1893, $3,500 were appropriated to establish a fog bell at this point. The precise location of this fog bell has not yet been fixed. Plans for the necessary structures are being prepared.

958. *Point No Point, Puget Sound, Washington.*—It appears that the present fog bell at Point No Point does not satisfy the needs of the service. It is recommended, therefore, that a first-class fog signal be installed in place of the bell. It is estimated that this can be done for $6,000, and it is hoped that the general appropriation for fog signals will be sufficiently large to enable the Board to pay this amount therefrom.

989. *Turn Point, west end of Stuart Island, Canal de Haro, Washington.*—On December 27, 1892, contract was made for the construction of the dwelling, fog-signal building, barn, water tanks, etc., at this station. The work was commenced early in March, and was pushed as fast as the conditions of the weather would permit. The fog-signal building and barn were completed, and the dwelling is about finished. Part of the fog-signal machinery was delivered at the station. A suitable post was erected for the stake light, and the station is ready for the keepers.

990. *Patos Island, entrance to Canal de Haro, Washington.*—On December 27, 1892, contract was made for the construction of a double dwelling, fog-signal building, water tanks, etc., at this station. The work was commenced early in March, and was completed on June 24, 1893. Part of the fog-signal machinery was delivered at the station. A suitable post was set for the stake light, and the station is now ready for a keeper.

—. *Mary Island light-station, Alaska.*—A custom-house has been established here; hence many vessels are obliged to make this a place of call. A small, inexpensive light, say a lens-lantern beacon, would assist vessels to make the port at night and hold on. The beacon could

Thirteenth District.

be kept by one of the custom-house employés. It is estimated that it could be established and maintained a year for $800, and it is recommended that an appropriation of that amount be made for this purpose.

—. *Post lights in Puget Sound and its tributary or adjacent waters, Washington.*—These lights are efficient aids to navigation in the inland waters of this district. Several new ones were established during the past year. The keepers did their work well. Petitions were received from various localities for the establishment of other post lights. If funds were available, a dozen new post lights could be placed advantageously in the rivers, bays, and channels of this district. The light-house tenders delivered the yearly supplies to all the lights. With the exception of Skagit River, Port Susan, etc., all post lights were inspected during the year.

The following recommendations, which were made in the annual reports of the Board for the last three years, are renewed:

The post lights in the Columbia and Willamette rivers, in Puget Sound and in adjacent waters, are of great benefit to navigation, and night boats now run regularly on the Columbia and Willamette rivers. They are of much use during fog, as the lights can be seen, except in very dense fogs, at a distance of 100 yards or more, and the pilots rely on the lights for a new departure. Without their aid night boats could not run regularly. The demand for these lights on Puget Sound and its tributary rivers is increasing with the growing commerce. The Board recommends, therefore, the establishment of thirty post lights along the navigable channels of the Snohomish River, the Skagit River, the Nooksack River, and the La Connor Slough, and along such other channels of Puget Sound and the rivers tributary thereto, in the State of Washington, as may be necessary to meet the requirements of commerce.

REPAIRS.

Repairs were made at the following-named stations:

891. Cape Arago, Oregon.
948. Willapa Bay, Wash.
949. Destruction Island, Wash.
958. Point No Point, Wash.
960. West Point, Wash.

LIGHT-SHIPS.

897. *Columbia River light-vessel, No. 50, off the Columbia River Bar, Washington.*—Slight repairs were made to her windlass during the year. The vessel was in position from April, 1892, and proved to be a great success and a valuable aid to navigation. She rode out with ease the exceptionally heavy gales of the past winter. At the request of the ship masters and pilots, she was moved on July 6 three miles southeast of her old position. The change is beneficial to vessels making for the Columbia River and also to the light-ship, for, should she break adrift, she ought now to be able to reach the river. In her old position the nearest port was in the Strait of Juan de Fuca.

Thirteenth District.

—. *Umatilla Reef light-vessel, Pacific Ocean, off the Strait of Juan de Fuca, Washington.*—The steamer *Michigan* was wrecked in January, 1893, by striking on Umatilla Reef, which is just off Flattery Rocks, coast of Washington, and is some 30 miles south of Bonilla Point, off the southwest coast of Vancouver Island, which lies like a bar across the course of northward-bound vessels. Although no lives were lost by the wreck of the *Michigan*, both vessel and cargo were destroyed. This wreck has called renewed attention to the fact that since our vessels have been sailing on this coast some thirty have been lost in running northward for the entrance to the Strait of Juan de Fuca. The coast of Washington, north of Point Greenville, is quite dangerous because of the great number of outlying rocks and the low-lying land of the neighboring coast. At latitude 48° 10′ the Flattery Rocks extend farther westward than any point of the coast of California, Oregon, or Washington, and being to the westward of the Cape Flattery light, on Tatoosh Island, which is only 13 miles to the northward, they are the greatest danger to navigation on the northern coast. In thick, stormy, winter weather, a vessel bound north, with a departure from Cape Orford light, can run 320 miles without a check, and must for safety's sake keep off from the very coast she wishes to make. As little if anything is known of the set of the currents near the great inlet of the Strait of Juan de Fuca, a vessel when in those waters may be largely in error as to her position; hence she takes a great risk in running to the eastward when her "distance is up" as to time; and yet this has to be done when steamers are making schedule time. It is difficult and dangerous to attempt to find the entrance to the strait in fog, and fog prevails there to a large extent. The *Fauntleroy* lay off that entrance once for seven days in a heavy southeaster and densely thick weather, not daring to attempt to make the entrance. The densest and blackest fogs of that foggy coast hang about the mouth of the strait.

Vessels bound to the northward do not voluntarily go near enough to the shore to hear the whistling buoy off Flattery Rocks. The coast from Umatilla Reef to Tatoosh Island, a distance of 13½ miles, is full of rocky islets and submerged dangers. The currents are strong and uncertain, and have a trend toward the shores which lie both to the northward and eastward. From various causes vessels fail to hear the steam fog signal at Tatoosh Island light-station, and hence are uncertain as to whether or not they have arrived off the entrance to the Strait of Juan de Fuca.

A light-ship with a steam fog signal, if anchored in some 30 fathoms of water, off Umatilla Reef of the Flattery Rocks, would enable vessels to take a clean departure and make the entrance to the strait and to clear Duncan and the Duntzé rocks which are marked by the red ray of Cape Flattery light. It is estimated that a proper light-vessel, one with steam motive power which could take care of herself in case she

Thirteenth District.

was torn from her moorings, and one with the most powerful steam fog signal, could be built and placed there for not exceeding $80,000, and it is recommended that an appropriation of this amount be made therefor.

DAY OR UNLIGHTED BEACONS.

The following-named new beacons or day marks were established in Alaskan waters in June, 1893.

Walden Rocks, Clarence Strait.—An iron spindle 20 feet high with a barrel on top painted in black and white horizontal stripes.

Columbine Rock, Neva Strait.—An iron spindle 20 feet high with a barrel on top painted in black and white horizontal stripes.

Neva Point Reef, Neva Strait.—An iron spindle 20 feet high with a barrel on top painted in black and white horizontal stripes.

In addition to these new aids, all the day marks, previously established in Alaskan waters, were thoroughly repaired and renovated; in many cases built new.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

896. Tillamook Rock, Oregon.—The first-class siren, in duplicate, was in operation about 206 hours and consumed some 11 tons of coal.

897. Columbia River light-vessel, No. 50, Washington.—The 12-inch steam whistle was in operation about 573 hours, and consumed some 53 tons of coal.

949. Destruction Island, Washington.—This first-class steam siren, in duplicate, was in operation about 555 hours, and consumed some 31 tons of coal and about 250 feet of wood.

950. Cape Flattery, Washington.—This 12-inch steam whistle was in operation about 446 hours and consumed some 27 tons of coal and about 69 feet of wood.

952. New Dungeness, Washington.—The 12-inch steam whistle was in operation 518 hours and consumed about 31 tons of coal and some 931 feet of wood.

954. Point Wilson, Washington.—The 12-inch steam whistle was in operation about 366 hours, and consumed some 31 tons of coal and about 68 feet of wood.

960. West Point, Washington.—The Daboll trumpet was in operation about 373 hours, and consumed some 3 tons of coal and about 100 feet of wood.

962. Robinson Point, Washington.—The 12-inch steam whistle was in operation 162 hours and consumed about 13 tons of coal.

989. Turn Point, Washington.—The Daboll trumpet is not yet finished.

990. Patos Island, Washington.—The Daboll trumpet is not yet finished.

Thirteenth District.

BUOYAGE.

The buoyage is in excellent condition. Every buoy in the district was changed during the year; some of the more important ones were ... three or four times. Every buoy is now in its place. The ...lly severe winter and its heavy gales were quite destructive ...t and river buoyage. Twice the ice in the Columbia River, ...ria, carried away every buoy, together with many beacons ...ghts. Some were a total loss. Five whistling buoys went ...ng the winter. Four were recovered. One at Netart's Beach ...overed during the summer. One bell buoy was sunk in the ...mbia. During June, 1893, four of the buoys in Alaskan ...e changed to a larger size and seven new buoys were estab... addition to the establishing of several buoys on the Oregon ... in the river, a whistling buoy was placed in January off ...ay, Wash.

DEPOT.

...Point, Columbia River, Oregon.—By act of Congress approved ...1892, authority was given for the use of the appropriation of ...ade on March 3, 1891, for removing the depot, in its repair ...ion. On March 6, 1893, contract was made for building an ...to the wharf, repairing the old wharf and moving the coal ... March 7, 1893, a contract was made to erect a new store-...alvanized iron on the new wharf. The wharf contractors ...ed, by unusually severe weather, in driving the piles. They ...y completed the new wharf and have made much progress ...airs to the old one. The contractors for the construction of ...ouse have put up the framework and are preparing to put ...ugated iron covering.

...eral oil at the depot is stored in a wooden building on the ...he main ship channel is within 200 feet; high-pressure river ...are passing every hour; they use wood for fuel and throw ...g cinders, which at times lodge on the wharf. It is proposed ...wo inexpensive oil houses (such as are used at the various ...ons), on solid ground at the end of the wharf, in which to ...oil.

TENDERS.

...zanita.—This steamer was constantly employed in the buoy-... district, landing supplies, fuel, construction material, trans-...echanics and making inspection trips. When bar bound at ...e crew was employed at the buoy depot. During the year ...d 15,423 miles and consumed 1,108 tons of bituminous coal. ...nder steam 332 days and worked 455 hours at the buoy depot.

Thirteenth District.

The tender changed 221 buoys and repainted 115; erected, repaired, and painted 33 beacons. She delivered at the various light-stations the annual allowances of supplies, 373 tons of coal, 17 cords of wood, 25,000 brick, 32,000 feet of lumber, and other material for construction and repair. She made 44 inspection trips. Being the only tender in this large and rough district, until the arrival of the *Columbine* in April last, her services were absolutely needed and the repairs she required had to be postponed.

The Columbine.—This steam tender left New York on October 30, 1892, in command of Lieut. Commander C. H. West, U. S. Navy. She arrived in San Francisco, Cal., on January 28, 1893. Damages caused during the long sea voyage were repaired at that port. On April 21, 1893, she reported at Portland, Oregon, for duty in the district. It was found necessary to make several changes and alterations to fit her for buoy work on this rough and boisterous coast. A heavier foremast and derrick boom were put in, buoy fenders were secured to the hull, her ports were cut in two, her ironwork was strengthened, and other minor repairs were made. On May 26, 1893, she left for Alaska, to attend to the yearly buoy work in those waters. She made the trip and did the work in 25 days, making the quickest trip on record. She established 12 new aids; changed, cleaned, and painted 47 buoys; and repaired and renovated 12 beacons. She proved herself an excellent sea boat, well adapted for her work. Since May 15, 1893, she steamed 2,566 miles, consuming about 233 tons of bituminous coal.

FOURTEENTH DISTRICT.

The fourteenth district extends, on the Ohio River, from Pittsburg, Pa., to Cairo, Ill., 966 miles; on the Tennessee River, 255½ miles; and on the Great Kanawha, 73½ miles; in all, a distance of 1,295 miles, and s all the aids to navigation within these limits.

tor.—Commander Edwin M. Shepard, U. S. Navy, to May 1, ice then Lieut. Commander F. W. Crocker, U. S. Navy.

er.—Lieut. Col. Amos Stickney, Corps of Engineers, U. S.

are in this district—

ı	496
ights	35
pers	488
f post lights discontinued	0
f post lights established	2
' floating lights discontined	0
f floating lights established	2
oldenrod, for supply and inspection	1

inspection trips were made during the year. The last trip hed on June 27. On this trip all the lights of the district ited; the posts were painted, the lights were renewed, the d trees were cut as needed, and everything was left in good ı. Supplies also were placed to last until November, so that of low water the lights would suffer no interruption until trip. At the end of the trip the number of the crew of the *d* was reduced as usual. A few lights were shifted on the ver, on account of the change of channel. The light-keepers a whole, done their work fairly well. Considering the whole of lights, the proportion of complaints were small.

TENDER.

oldenrod.—The steamer is in excellent condition, and is well her work. A new Ward boiler was substituted for the old nkey boiler. The *Goldenrod* steamed during the year, 9,429 nsuming 797 tons of coal. She distributed 18,597 gallons of ,134 trees, cut about 66 acres of brush and willows, reset 116 d moved 10 lights.

FIFTEENTH DISTRICT.

The fifteenth district extends on the Mississippi River from the head of navigation to Cairo, Ill., on the Missouri River to Kansas City, Mo., and on the Illinois River from La Salle to its mouth, being in all a distance of 1,582½ miles, and embraces all the aids to navigation within these limits.

Inspector.—Commander William C. Wise, U. S. Navy.

Engineer.—Lieut. Col. Charles R. Suter, Corps of Engineers, U. S. Army.

Number of lights	514
Number of keepers	323
Number of channel marks	88
Number of trees cut	635
Number of acres cleared	4¼
Number of gallons of oil used	13,925¼

During the year the efficiency of the district was well maintained, in spite of extraordinary condition of the weather, floods, and ice. Several stations were destroyed, but all have been replaced. Several outfits of oil were lost by the burning down of the keeper's house. The number of lights was gradually increased, giving satisfaction and security to the river traffic. The number of lights on the Illinois and Missouri rivers remains substantially the same, as there is no material increase of commerce on these rivers. The total number of lights is 514—being an increase of 9 during the year.

TENDER.

The Lily.—This steamer made twelve trips during the year, steaming about 8,800 miles and consuming some 1,398 tons of coal and 6 cords of wood. The old upright engine was replaced by a new 5-horse power Westinghouse engine for the electric light. It gives satisfaction. The hurricane roof was recovered with No. 10 canvas. In making repairs the crew were utilized without calling in outside workmen. The hull is rapidly deteriorating; it is now thirteen years old, and it will be necessary after the fall work is ended that she be hauled out and thoroughly repaired.

Fifteenth District.

The legislature of the State of Minnesota, at its last session, passed an act, a copy of which is subjoined, for the better protection of the post lights within the State lines:

AN ACT to protect Government lights and light-house stations on the navigable waters of this State.

Be it enacted by the legislature of the State of Minnesota, as follows:

SECTION 1. Every person who shall willfully break, injure, deface, or destroy any light-house station, post, platform, steps, lamp, or other structure pertaining to such light-house station, or shall extinguish any light erected by the United States upon or along the navigable waters of this State to aid in the navigation thereof (if such offense be not punishable by the laws of the United States), shall, upon conviction, be adjudged guilty of a misdemeanor and punished by imprisonment in the county jail not exceeding one year, or by fine not exceeding $100, or by both such fine and imprisonment.

SECTION 2. Every person who shall willfully break, injure, deface, or destroy any light-house station, post, platform, steps, lamp, or other structure pertaining to such light-house station, the same being the property of the United States, or shall extinguish any light erected by the United States upon or along any of the navigable waters of this State to aid in the navigation thereof, with intent to endanger the safety of any vessel or vessels navigating said waters, or to jeopardize the safety of any person or persons or property in or upon said vessel or vessels, shall (if such offense be not punishable by the laws of the United States), on conviction, be adjudged guilty of a felony and be punishable by imprisonment in the penitentiary for a term not exceeding five years.

SECTION 3. Every person or persons who shall moor any vessel or vessels of any kind or name whatsoever, or any boat, skiff, barge, scow, raft, or part of a raft to any buoy or beacon placed in the navigable waters of the State, or in any bay, river or arm of the sea bordering upon this State, by authority of the United States Light-House Board, or shall in any manner hang on with any vessel, boat, skiff, barge, scow, raft, or part of a raft to any buoy or beacon, or shall cut down, remove, damage or destroy any beacon or beacons erected on land in this State by the authority of the said United States Light-House Board, shall for every offense be deemed guilty of a misdemeanor, and, upon conviction thereof, before any court of competent jurisdiction, shall be punished by a fine of not less than $100 nor more than $200, or by imprisonment in the county jail not less than one or more than six months, or by both such fine and imprisonment, in the discretion of the court.

SECTION 4. That one-half of all fines under this act shall be paid by the court to the informer, and that the other half shall be paid into the common-school fund of the county in which the action shall be tried.

SECTION 5. This act shall take effect and be in force from and after its passage.

SIXTEENTH DISTRICT.

The sixteenth district extends on the Mississippi River from Cairo, Ill., to New Orleans, La., and on the Red River a distance of 8 miles, being in all a distance of 1009 miles, and embraces all the aids to navigation within these limits.

Inspector.—Lieut. Commander Robert M. Berry, U. S. Navy, to December 31, 1892; Commander Andrew J. Iverson from December 31, 1892.

Engineer.—Lieut. Col. Charles R. Suter, Corps of Engineers, U. S. Army.

In this district there are—

Post lights	344
Number of keepers	324
Steamer *Joseph Henry*, for supplies and inspection	1

POST LIGHTS.

There are in the sixteenth district, 344 post lights, cared for by 324 keepers, an increase of 3 lights and a decrease of 3 keepers in the past twelve months. The post lights are separated by an average distance of less than 3 miles. The demand from masters and pilots for an increase in the number of lights is urgent. The argument advanced in favor of this is that the Mississippi River between St. Louis, Mo., and Cairo, Ill., a distance of 194 miles, is furnished with 115 post lights, an average of 1 light for less than each 1¾ miles, and that the interests of navigation demand an equally effective lighting of the river between Cairo and New Orleans. The condition of the post lights and their outfits, and the efficiency of the service rendered by the keepers, is satisfactory. The district has just been provided with 100 new brass lanterns, of the improved No. 2 Marine Signal pattern, equipped with white Fresnel globes, and burners carrying an inch wick. This gives promise of being the best lantern yet provided for the lighting of the river; as it is made of brass the constant repairs and corresponding expense caused by the use of the tin reflectors will be avoided.

The aggregate amount of the monthly pay-roll of the laborers attending post lights at this date is $3,025, an average expense of $8.80 per month per post light, as compared with $9.02, the average amount paid during the last fiscal year. Complete inspections of the entire district were made during each quarter, in addition to which a short patrol trip was made in the latter part of October, 1892.

Sixteenth District.

The following is an exhibit of the work done during the year:

Number of post lights visited, inspected, paid, and supplied	1,407
Number post lights established	36
Number of post lights discontinued	33
Number post lights moved	247
Number of keepers discharged	114
Number of keepers appointed	111
Number of trees felled (over 4 inches in diameter,)	3,840
Number of acres of willows, brush, etc., cleared	134
Number of gallons of mineral oil issued to keepers	13,568

TENDER.

The Joseph Henry.—This steamer received various minor repairs.

There is now being placed on the tender a system of heating by steam, which when completed, will furnish the desired temperature in winter, and do away with the stoves heretofore used. This will materially lessen the chance of loss by fire.

During the year the tender steamed about 8,954 miles, and consumed about 1,065 gross tons of coal, at an average cost of $3.10 per ton.

She was under steam, exclusive of 238 days on the donkey boiler. 119 days.

CONCLUSION.

In concluding this report, the Board takes pleasure in stating that each of the sixteen light-house districts into which the establishment is divided is in good working condition.

All of which is respectfully submitted.

JAS. A. GREER,
Rear-Admiral, U. S. Navy, Chairman.

R. D. EVANS,
Captain, U. S. Navy, Naval Secretary.

F. A. MAHAN,
Captain of Engineers, U. S. Army, Engineer Secretary.

The SECRETARY OF THE TREASURY.

REPORT OF THE LIGHT-HOUSE BOARD.

APPENDIX No. 1.

REPORT

UPON THE

ELECTRIC-BUOY PLANT IN NEW YORK LOWER BAY AND IN LAKE MICHIGAN ON THE WATER FRONT OF CHICAGO, ILLINOIS.

BY

LIEUT. COMMANDER CLIFFORD H. WEST, U. S. NAVY.

Assistant to the Inspector of the Third Light-House District.

THE ELECTRIC-BUOY PLANT IN NEW YORK LOWER BAY AND AT CHICAGO, ILL.

OFFICE OF INSPECTOR, THIRD DISTRICT,
Tompkinsville, N. Y., August 5, 1893.

SIR: In obedience to your verbal order, I have the honor to submit the following report for the fiscal year of 1892-'93 as to the condition and efficiency of the electric-buoy plant in New York Lower Bay, comprising six lighted buoys in Gedney Channel and one lighted buoy on Southwest Spit.

I have also to submit a report as to the electric buoys established by the Light-House Board in Lake Michigan, marking the path of the water route from the city of Chicago to the grounds of the World's Fair.

Except as to the items noted below the Sandy Hook electric-buoy plant is generally in very good working order, and continues to be one of the most important aids to navigation under the control of the Light-House Establishment. I can not but reiterate in this report all the arguments in favor of this plant that I set forth in my lengthy and detailed report for the fiscal year of 1891-'92. The buoys are held in increased estimation by the pilots and sea-faring community of New York, as is shown by the steady increase of vessels passing Sandy Hook bar at night in all weathers and even in fog.

The monthly increase of vessels passing the bar between sunset and sunrise for the fiscal year of 1892-'93 over 1891-'92 is 7.3 per cent, while the increase of 1892-'93 over that of 1888-'89 (the year the buoys were first lighted) is 119.3 per cent.

The past winter of 1892-'93 was the most severe experienced about New York for about twenty years. All buoys in New York Harbor were more or less displaced at times by the huge fields of floating ice, and the daily services of two light-house tenders were employed for several weeks to keep the buoys in their proper positions. During this almost unprecedented ice season it was found to be impossible to properly display the incandescent lamps on the buoys. Huge balls of ice froze on the heads of the buoys, and when the buoys themselves dipped below the floating fields of ice the buoy lanterns with their various attachments were in danger of being carried away by the blows of the ice pack The lanterns, etc., were therefore unshipped from the buoys and taken on shore. On account of this severe ice season the electric-buoy plant was not operated from January 13, 1893, to March 7, 1893, or a period of about eight weeks.

But this very temporary cessation of the lighting proved the extreme usefulness of the system, as in the month of February only 11 vessels passed over the bar between sunset and sunrise, while for the same month of 1892, when there was little or no ice, 80 vessels crossed the bar. From the fact that 10 of these 11 vessels went to sea, while only 1 entered port, it is plain that the cessation of passing the bar was not due to fields of ice, but to a hesitation on the part of pilots to enter port unless the bar's limits were accurately marked by the lighted buoys. The observer of the New York Maritime Exchange at Sandy Hook reports that when the buoys were not lighted a great number of vessels approached Sandy Hook bar at night as far as the pilots considered it prudent, and would then cast anchor until daylight came for finding their way into port. No more convincing demonstration of the usefulness of the lighted buoys could be given than a citation of these facts.

Although the system was thus temporarily suspended through the rigors of nature, it is not probable that such a winter will be of frequent occurrence unless the climate of this latitude has suddenly undergone great changes. The two months' suspension of the system really amounts to a very small percentage of its five years of usefulness since 1888, and should such a severe winter not occur again for another twenty years the matter of the temporary nonlighting would really become a vanishing factor in comparison with the greatly preponderating beneficent results.

Repairs Needed.

The two vertical cylindrical tubular boilers, each of 10 horse power, have now been in almost constant use at the station for the past five years, and are beginning to require frequent repairs. I would respectfully recommend that a 25 horse power locomotive tubular boiler be at once supplied the station to alternate in use with the two vertical boilers. The vertical type of boiler has been found exceedingly difficult to repair as to the tubes. The bad quality of fresh water at this station has also had an injurious effect as to sediment on the crown sheet, etc., of the vertical boilers which the type of horizontal boiler would neutralize.

The electric cables are generally in good condition except the single conductors from the junction boxes to each buoy. During the present summer these cables will be replaced by new ones already in stock.

The west side of Sandy Hook having made out some 250 feet to the westward during the past year, the cable leading to Southwest Spit Buoy (No. 12) is now practically covered by a sand bank, but this burying of the cable will cause no bad effects.

The new method of splicing the conducting wires of cables by an ordinary junction tube instead of soldering them, as formerly done, has met with great success. It is found that the new method prevents the splices from burning out as they frequently did with solder.

The land wire lines leading to the main cables at the north end of the Hook are getting to be drawn very fine by their mere weight, so that they may have to be replaced by new wires during the coming year.

The engines, dynamos, power house, and keeper's dwellings are in good repair.

The quality of coal supplied this station during the past year has been of a far superior quality to that formerly furnished, and good results have been therefore shown in keeping up steam and in economy of expenditure.

A length of 850 feet of piping has been laid from the power house to the sea front for watering the steam launch.

The old steam launch of the *Armeria* is still used by the keepers of the station to make occasional repairs to the cables. The hull of the launch is good, but the boiler is weak from many soft patches. The engine has much lost motion as to the eccentrics, etc., which it is impossible to fully correct on account of the worn down condition of the bearings.

On November 25, 1892, Mr. J. T. Dixon succeeded Mr. W. S. Brown, as keeper in charge of the station, and under his care the high efficiency of the station has been maintained.

Appended hereto is Table 1 showing the number of vessels which have made use of the lighted buoys in passing the bar between sunset and sunrise during the fiscal year of 1892-'93. There is also a general synopsis and percentage of results from the inception of the system. It is noteworthy that these are highly gratifying, and fully demonstrate the increased usefulness of the Sandy Hook electric-buoy plant.

Report as to the Electric Buoys Established in Lake Michigan near Chicago.

The United States Light-House Board, by its letter of March 8, 1893, directed the inspector of the third light-house district on account of his extensive experience

with electric-lighted buoys, to formulate a plan for lighting the Chicago water front with lighted buoys for a distance of about 7 miles, or from the breakwater near Van Buren Street dock to the Casino dock on the grounds of the World's Fair. These buoys were to indicate a highway by day and by night for the many steamers plying between Chicago and the Casino dock, guiding them clear of the numerous shoals making out into Lake Michigan from the main shore. The Board ordered that the plant be temporarily maintained during the period of the Exposition.

The electric buoys, besides being of benefit to the commerce of Lake Michigan, would also illustrate to the multitudes of people visiting the Exposition this plan of lighting harbors (which has been successfully operated for five years past in the waters of New York Bay), and thus bring the particular merits of the system to the attention of the world.

As you are aware, several difficulties presented themselves on first viewing the situation as to the distance to be lighted. The details of the system adopted in New York Bay, where each buoy is supplied by an independent copper wire, were found to be impracticable at Chicago, on account of the long distance to be lighted (7 miles), as well as the large number of buoys employed. The New York system applied there would require enormous cables and a great amount of copper for the conductors. Such requirements rendered the New York system unattainable at Chicago from a pecuniary standpoint.

To reduce the size of the cables and number of conductors two other plans were considered:

(1) Of running the main cable in a trench along the shore line and having it tapped by separate feeders to each buoy.

(2) By having one main cable from each end of the plant, thus dividing the work between them of supplying the current to the 13 buoys, each cable being supplied by a separate dynamo. After full consideration both these devices were rejected as presenting insurmountable objections.

The only plans that remained to be regarded were the high-tension systems:

(1) As to the multiple system of lighting.

(2) The high-tension system either with an alternating current or with a direct constant current.

The multiple system of lighting was rejected as necessitating two right-angle splices under water to the main cable at each buoy, which would be difficult to keep in order, as well as being comparatively inaccessible. Another objection was the necessity of having different sizes of conductors in the cable at various distances from the dynamo, in order to maintain the lamps at the same photometric power.

The high-tension series system was then considered:

(1) As to an alternating current.

(2) As to a direct, constant current.

It was first proposed to use the alternating current with a converter or transformer on the Casino dock, and a small converter in the head of each buoy, so that each lamp would be lighted by an induced current, and thus render the main circuit independent of accidents resulting to any number of lamps. For lack of time the converters for buoys were not made, but an ordinary shunt coil substituted in the buoy head, thereby reducing the voltage of the main current to 100 for each buoy lamp.

Therefore in general terms experiments were first begun with a high-tension series system, alternating current, using a main converter on shore and a small shunt coil in the head of each of the buoys. The details of the system are described as follows:

SUBMARINE CABLE.

Length 13.5 miles from end of Casino dock and return, at which point the land wires of the Exposition formed conductors to the dynamo. Conductor of cable made

of seven No. 16 B. & S. copper wires, insulated to 0.365 of an inch, with three coats of purest, well-seasoned gutta-percha, then served with two coats of fine jute. Protected outside by one armor of 16 No. 5 B. & S. wires. External diameter of cable, 1 inch. Armor wire galvanized, but not with extra coating (as in New York waters), the water of Lake Michigan being fresh. Weight 1.3 pounds to the foot. Copper core very flexible and whole cable easily handled and not liable to kink. Insulation 1,000 megohms per mile. Capacity 0.31 microfarads per mile. The cable is considered the best as to insulation yet turned out by the Bishop Gutta-Percha Company.

At each buoy, at a point 2 feet above the water line, the cable was cut in two and a small rubber insulated conductor spliced in each end of the cable to carry the current to the lamps. This was done to avoid carrying the considerable weight of the cable above the supporting surface of the water, as well as to protect the gutta-percha of cable from the direct rays of the sun.

The small rubber insulated conductor was made as follows:

Copper conductor formed of 12 wires, No. 19 B. & S. Three layers of rubber—first, brown rubber; second, white core; third, vulcanized rubber. Outside of all was rubber tape, and then a braid which had been boiled in a water-proof compound.

Insulation, 2,000 megohms per mile.

Capacity, 0.28 microfarads per mile.

This rubber conductor was laid in a groove in the buoy and protected by battens from outside friction. The rubber insulated wire was spliced to main cable by a small copper sleeve. Hot metal, half and half solder (tin and lead), was poured over joint. A normal gutta-percha joint was made. This was lapped over with jute, wound with tape and finally shellaced.

BUOY, ETC.

Thirteen buoys of juniper (cedar) wood, anchored by seven first-class, cast-iron sinkers (3,300 pounds each) and six second-class sinkers (1,800 pounds each), in depths of water varying from 17 to 30 feet. Height of lamps above water level, about 12 feet. A shunt coil (per sketch annexed) in the head of each buoy to reduce voltage to 100.

LAMPS.

Edison incandescent, 5-inch globe, spiral filament, 100-candle power, 4.6 to 6 ampères.

ELECTRICAL APPARATUS.

On switch board in cable house, end of Casino dock. One main converter (transformer). Two single, pole-knife switches. Two Hill switch and fuse boxes. Two Wurtz lightning arresters. Alternating current supplied by the Exposition authorities from a 10,000-light Westinghouse dynamo.

Current delivered at 2,200 volts and transformed down to 1,460 volts.

Experiments of Friday night, June 23, 1893.—First test: Converter used; a secondary induced current of 1,460 volts; current 1.5 ampères; 13 buoy lamps brought up to only a cherry-red incandescence.

Second test: Primary current used without converter; volts 2,200; current 0.75 ampères; 13 lamps slightly brighter incandescence.

Third test: Converter connected in series with primary current, multiple series system; volts, 3,360; no current whatever apparent by ammeter; six pilot lamps of 100 volts, 5 ampères, illuminated above candle power, with only one pole of dynamo connected, showing Tesler effect and great capacity of armor of cable. Buoy lamps slightly incandescent. In the third test when the current was grounded to armor of cable, the lamps came up to higher candle power, but the head of buoy (No. 1),

nearest Casino dock, displayed balls of fire as big as cocoanuts, and severe shocks were felt at switchboard. The head of No. 1 buoy was afterwards found to be badly burned, the current following the course of iron bolts in buoy head. The experiment showed the armor of cable to act as a sort of condenser. A strong contra-electromotive force was thus induced, rendering difficult the passage of any current through the main conductor. Alternations amounting to 16,000 were first used with the dynamos. These were afterwards reduced to 7,000, with no beneficial effect. Except in the vicinity of No. 1 buoy, the cable showed good insulation, after these somewhat crucial tests with a very high potential. If the Edison lamps had been made for a current of 3.2 ampères (upon which their lighting was predicated) instead of for 4.6 to 6 ampères (as used) it remains to be seen if better results as to their incandescence could not have been obtained.

As the alternating system as thus applied was found to be impracticable, it was finally decided to remove all the shunt coils and Edison lamps from the heads of buoys, and adopt the high-tension series system with a direct and constant current, using 100-candle power Bernstein lamps.

Accordingly, on the night of Saturday, July 1, 1893, the plant was so put into operation with successful and gratifying results as to the brilliancy of all the lamps. The current of 10 ampères is supplied by a Fort Wayne arc dynamo of 2,200 volts between terminals, which also feeds twenty-four arc lamps located in Machinery Hall of the Exposition. At this date of writing the plant is still in successful operation. This system, however, has the disadvantage of a liability of burning out the dynamo in case of a ground to the cable. On the contrary with the alternating current and a main converter the dynamo is independent of such accidents, which could only result in burning out a fuse plug at the converter.

As this length of submarine cable (13.5 miles) is the longest thus far used in the world for electric lighting, the experiments were watched with more than usual interest by many electrical experts at the World's Fair.

In view of the new conditions there presented in electrical science, and of the widespread interest manifested, I would respectfully suggest that further experiments be conducted on or about October 10, next, with the present plant, care being taken by Government officers present that the cable be not subjected to undue strain. As the alternating current is the more elastic, and, in the opinion of many prominent experts, the current of the future, it would perhaps be advisable to conduct the experiments with that current. Very slight modifications in the present plant would be needed. The main converter is already in place and a small converter could be made for the head of one buoy, together with a lamp of proper resistance.

With results thus obtained valuable data might be determined involving the whole future of subaqueous electric lighting, as to its efficiency and economy, and consequent further adoption by the United States Light-House Establishment.

Very respectfully, your obedient servant,

CLIFFORD H. WEST,
Lieutenant-Commander, U. S. Navy,
Assistant to Third Light-House Inspector.

Capt. W. S. SCHLEY, U. S. N.,
Inspector of the Third Light-House District, Tompkinsville, N. Y.

TABLE 1.—*Showing the number of vessels using the Gedney Channel, New York Lower Bay, between sunset and sunrise, in the fiscal year of 1892-'93.*

Year and month.	Bound in.	Bound out.	Total.	Remarks.
1892.				
July	34	13	47	
August	53	13	66	
September	51	18	69	
October	62	21	83	
November	52	29	81	
December	61	39	100	
1893.				
January	28	4	32	Heavy floating ice in New York Harbor rendered system inoperative from January 13 to March 7.
February	1	10	11	
March	29	17	46	
April	37	19	56	
May	41	24	65	
June	38	8	46	

SYNOPSIS.

Fiscal year of	1888-'89 (7 months).	1889-'90.	1890-'91.	1891-'92.	1892-'93 (10 months).
Total number of vessels:					
Coming in	171	377	470	533	487
Going out	53	192	297	252	215
Average per month:					
Coming in	24	31.4	39.1	44.4	48.7
Going out	8	16	24.7	21	21.5
Total	32	47.4	63.8	65.4	70.2

	Per cent.
Percentage of increase per month, 1892-'93 (70.2) over 1891-'92 (65.4)	7.3
Percentage of increase per month, 1892-'93 (70.2) over 1888-'89 (32)	119.3

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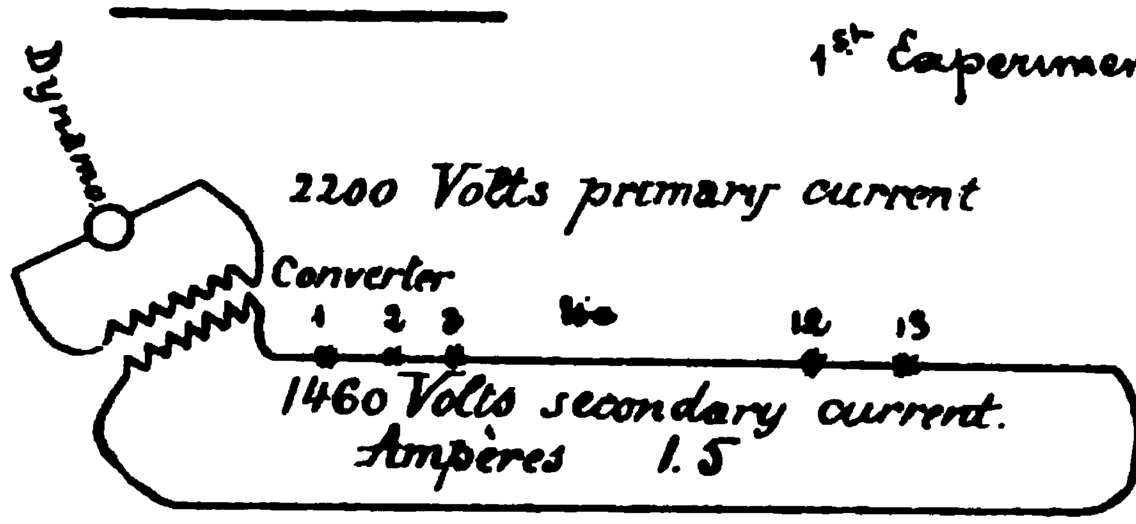
Graphic representation of experiments at Chicago with 13 Electric Buoys.

WESTINGHOUSE DYNAMO

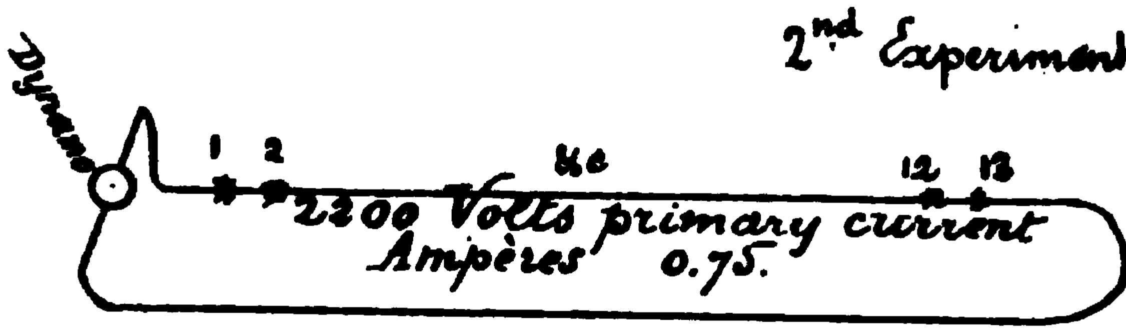
• Electric Buoys.

1st Experiment. (Alternating Current)

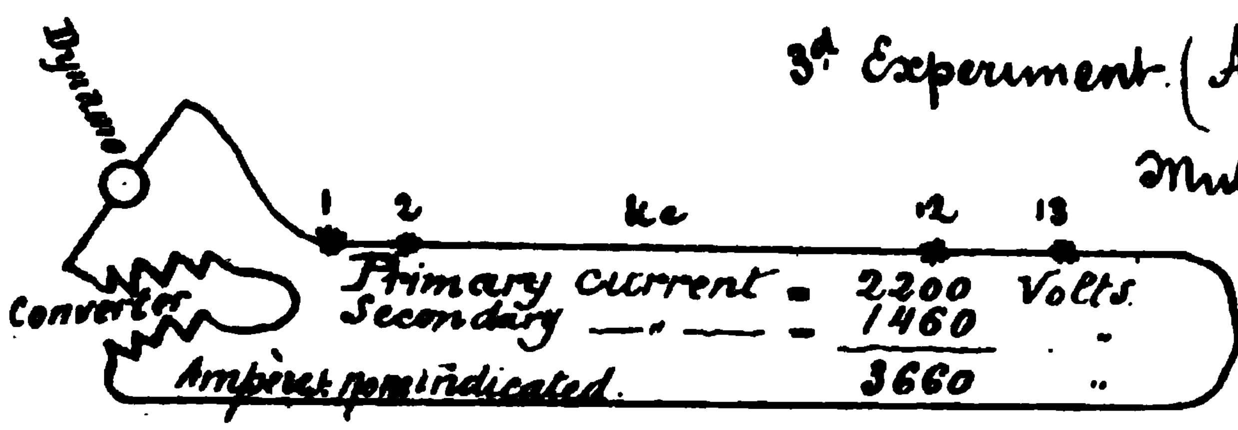


Edison lamps.
Shunt or series
Coil, head of
each buoy.

2nd Experiment (Alternating Current)

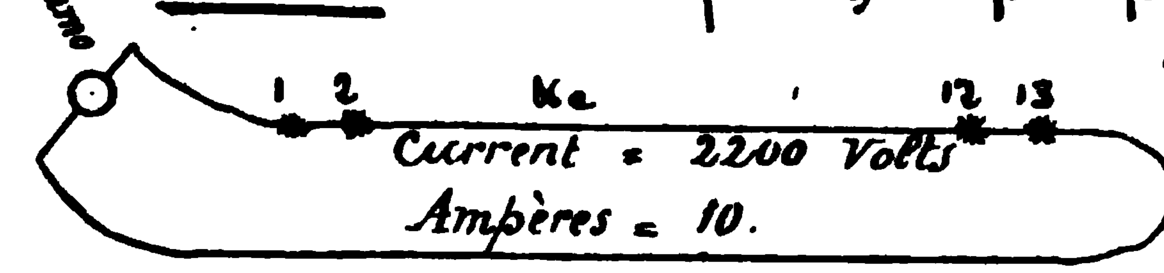


3d Experiment. (Alternating Current)
Multiple series system.



FORT WAYNE ARC DYNAMO

As finally adopted for use



Direct, constant current
Bernstein lamps.
No shunt coil in
head of buoys

ANNUAL REPORT TO CAPTAIN W. S. SCHLEY. U.S.N.
by
LIEUT.-COMMANDER CLIFFORD H. WEST
U.S.N.

REPORT OF THE LIGHT-HOUSE BOARD, 1893.

APPENDIX No. 2.

REPORT

UPON THE

ELECTRIC-LIGHTED BUOYS ON THE CHICAGO WATER FRONT, LAKE MICHIGAN, MAINTAINED DURING THE COLUMBIAN EXPOSITION.

BY

JOHN J. BRICE, COMMANDER, U. S. NAVY,

Inspector, Ninth Light-House District.

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THE ELECTRIC-LIGHTED BUOYS ON THE CHICAGO WATER FRONT, LAKE MICHIGAN.

OFFICE OF INSPECTOR, NINTH DISTRICT,
Chicago, Ill., July 15, 1893.

SIRS: I have the honor to submit the following report relating to the work and methods adopted in establishing electric buoy lights as a fairway, marking the channel from Van Buren Street wharf, Chicago, to the Casino wharf at the World's Fair, commencing May 1 in the preliminary work, by placing ordinary spar buoys to mark the line of electric lights.

The plan inclosed for locating the buoys was carried out and consists of 13 cedar buoys of different sizes adapted to the depth of water ranging from 19 to 30 feet. They are half a mile apart, (sketch) commencing one-half mile from the Casino wharf and running in a line passing halfway between the outer and inner Hyde Park Shoals, a mile and three-quarters from shore at the farthest point. Between these shoals, they turn at an angle and run in the direction of Van Buren Street wharf, the last, or thirteenth buoy being located one-half mile south of the Chicago South Breakwater.

The buoy is of cedar (sketch), with a cavity in the side large enough to admit two parts of the cable, and allow a batten to fit snugly over, after the splices are made. The cable enters the buoy about 3 feet from the heel, and passes up its entire length to the lamp, in a groove or slot cut in its side for the purpose. The buoys are anchored with iron sinkers of the first and second class. There is also an iron ring fitted in the eye of the strap on the buoy, which is used only for lowering the buoy in place by means of a slip rope. A scow was used, on which the buoys were fitted and the splices made, and when completed hoisted from the scow and lowered into place by the derrick of the light-house tender.

The cable used was manufactured by the Bishop Gutta-Percha Company, of New York, and is composed of No. 16 copper wire, with one-quarter inch gutta-percha insulation, protected by a jute bed of one-third inch, and armored by a galvanized-iron wire wrapped around spirally.

The cable attached to the buoys came in lengths of little more than half a mile, made up on 13 different reels, and the main cable on 3 separate reels, covering the distance of 7 miles. All of the cables were reeled off from a scow towed from buoy to buoy, the main cable being laid direct from the thirteenth buoy to the Casino wharf, outside or offshore from the buoy, to prevent its drifting inshore.

The original plan to light the electric buoys between Chicago and the World's Fair, was with an alternating current, the power to be taken from the World's Fair plant. A special converter or transformer was made to reduce the current from the World's Fair circuit of 2,000 volts down to 1,450 volts. Special shunt coils in series were used with the cable, the secondary terminal of which was connected with the lamp. On testing the cable, although the electromotor force was 1,450 volts, the current readings showed only 1.5 amperes going into the lamp, the capacity of the lamp at the time being 5.2 amperes for normal candle power. The power was then increased 3,300 volts, the current readings showing only 1.2 amperes with this increased force. The conclusion arrived at from these unexpected pecu-

liarities, and the failure of the system to operate successfully, is supposed to be the fault of the spiral-armored cable. It is maintained by the most skillful electricians here that the spiral armor acted as a condenser and induction so great took place that the working force was lost. The lamps used at this trial were especially made of 100-candle power and 5.2 amperes, 100 V. Edison lamps. After the trial and failure of the alternating system, the lamps and connections were changed to an arc or direct series system. The Edison lamps and shunt coils were removed from the head of the buoys, and a Bernstein lamp of 100-candle power and 10 amperes substituted, and with an electric percussion cap fuse introduced for continuing the uninterrupted current to the other lamps, in case of accident to the filament of a particular lamp. This fusible plug fits into a socket for which the Bernstein lamp is fitted (sketch) and closes the circuit when the filament breaks, which is accomplished by the percussion cap exploding when the current is forced through it by the destruction of the carbon filament, allowing the current to pass to the other lamp through this new channel.

The buoys have been lighted since the 4th of July (two weeks) by the direct current and have worked satisfactorily and without accident of any kind, with a visibility of 7 miles. So far we have experienced no difficulty with this mode of lighting, and the only objection to the direct current, I believe, for submarine work is that the cable is in direct circuit with the dynamo, consequently danger to the apparatus and life is increased by ground contacts.

The lighted fairway from Chicago to the World's Fair through somewhat dangerous shoals, has done away with all danger of accident by collision or running upon reefs. In fact the channel is as well pointed out as the pathway in the streets, calling forth expressions of admiration and satisfaction from the community for this new departure in lighting up the waters.

Respectfully,

J. J. Brice,
Commander, U. S. Navy,
Inspector Ninth Light-House District.

The Light-House Board,
Washington, D. C.

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REPORT OF THE LIGHT-HOUSE BOARD, 1893.

APPENDIX No. 3.

REPORT

UPON THE

ELECTRIC LIGHT-SHIP OFF CORNFIELD POINT, LONG ISLAND SOUND, CONN.

BY

WINFIELD S. SCHLEY, CAPTAIN, U. S. NAVY,

Inspector, Third Light-House District.

THE ELECTRIC LIGHT-SHIP AT CORNFIELD POINT, LONG ISLAND SOUND.

OFFICE OF INSPECTOR, THIRD DISTRICT,
Tompkinsville, N. Y., September 30, 1893.

SIRS: I have the honor to acknowledge the receipt of the Board's letter of September 4, requesting certain information as to the steam power, electric power, etc., of Cornfield Point light-ship.

This vessel was built at West Bay City, Mich., and completed July, 1892. The dimensions are as follows: Length over all, 118 feet 10 inches; length from inside of rudderpost to inside of stem, 110 feet; beam molded, 26 feet 6 inches; depth of hold from top of keel to top of beam, 14 feet 6 inches. The material of the hull is iron throughout, with a tensile strength of 48,000 pounds and an elongation of 16 per cent in 8 inches as a minimum. The material of the boilers is steel, with a tensile strength of between 58,000 and 67,000 pounds, with an elongation of not less than 22 per cent in 8 inches for shell plates, and a tensile strength of between 50,000 and 58,000 pounds, and an elongation of not less than 26 per cent in 8 inches for flange plates. The vessel is fitted with two continuous deck-stringers, is stiffened with breasthooks and five keelsons, also two outside bilge keels. The thickness of the plating is $\frac{8}{16}$, $\frac{7}{16}$, $\frac{6}{16}$ and $\frac{5}{16}$; the bulwarks $\frac{4}{16}$. The deck beams are of T-bulb pattern. Main deck is white pine, $3\frac{1}{2}$ inches; there is also a partial iron deck, consisting of stringer, tie-plates, mast and windlass plates of an average thickness of $\frac{7}{16}$ inch. The vessel is divided by four main bulkheads extending to the main deck. The accommodations for officers and crew consist of 1 cabin, 4 staterooms, and beds for 12 men. The vessel is fitted with a steam windlass with three wildcats to operate two 2-inch chains and one $1\frac{1}{2}$-inch chain. A Baird's No. 3 distilling apparatus is fitted in the deck-house, with condenser, aerater, filter, circulating pump, etc., complete. The whistle machinery consists of one horizontal noncondensing engine, 5-inch diameter, and 6 inches stroke, attached to the machinery for operating the steam whistle. The diameter of the whistle is 12 inches. There is a wrecking pump with 8-inch suction. The vessel has two masts and four lens lanterns on each mast, hung in brackets 55 feet above the water, and operated as described under heading "Electric plant." Just below the lamps are built round platforms, with a low wire rail serving as a day mark. These day marks are painted black. The vessel is painted red, with "CORNFIELD POINT LIGHT-VESSEL NO. 51." in white letters on her sides. She has a main stack, a donkey boiler stack, and the steam receiver for the whistle painted black. The boats, one on each side, are painted exactly as the vessel, with the number and name of ship. The deck house extends from about 6 feet abaft the mainmast to about 11 feet forward the main smokestack. The vessel has a raised forecastle 45 feet in length; her stern is elliptic, and her bow nearly straight, with hawse hole in the center. The characteristics of the vessel are as follows:

Daytime, day marks and lamps as described.

Nights, 4 lamps on each masthead operated by electricity.

In a fog,	Blast, 3 seconds.	Silent interval, 12 seconds.
	Blast, 3 seconds.	Silent interval, 12 seconds.

Engine.—The engine is a compound inverted surface condensing. Diameter of cylinders 14 inches and 24 inches; length of stroke 16 inches, indicated horse power 140 with steam pressure of 100 pounds per gauge.

Main boilers.—Two, cylindrical, 8 feet in diameter, 9 feet in length, fitted with Fox's corrugated furnaces 36 inches in diameter, constructed for a maximum steam pressure of 110 pounds per gauge, the grate surface being 35 square feet.

Donkey boiler.—One vertical, tubular 7 feet 3 inches in height and 54 inches in diameter. The grate surface is 11.5 square feet.

This boiler, designed and built to run the steam windlass and to heat the vessel only, has been connected to fog-signal engine and whistle receiver. While this boiler has capacity enough to blow the 12-inch whistle for a limited period, it is too small to run the fog signal for any length of time.

The cost of the above can not be given, as they are included in the gross contract price of the vessel, which is not known in this office.

Electric engines.—Two horizontal high-speed engines of the "Ideal" type, with automatic cut-off governor, capable of developing 8 horse power at normal speed with 70 pounds of steam, cutting off at a quarter stroke.

Dynamos.—Two dynamos of the Thomson-Houston type, compound wound, of 60 amperes capacity, with an electromotive force of about 110 volts at terminals of machine, automatically regulated so that three-fourths of the lamps can be extinguished with safety without material change of speed. The engines and dynamos are so located that with the Evans friction cones, either engine can run either or both dynamos.

Flashing device.—In the electric circuit there is a device for alternately opening and closing at regular intervals, the circuits to the eight incandescent lights at two mastheads.

Masthead lanterns.—There are four lens lanterns (with totally reflecting prisms) at each of the two mastheads. Each of the lens lanterns contains one 100-candle power incandescent lamp, or eight incandescent lamps in all the lanterns.

Lighting of decks of vessel.—Besides the incandescent lamps in lens lanterns the decks of the vessel are lighted by twenty 16-candle power incandescent lamps.

Cost.

Two Ideal engines with 4 pulleys	*$2,080.00
Two Thomson-Houston dynamos	
One ammeter	
One voltmeter	
One flashing device	
Eighteen 100-candle power incandescent lamps	
Forty 16-candle power incandescent lamps	
One spare armature	
Installation of the above, together with complete wiring of the vessel	185.00
Eight lens lanterns with totally reflecting prisms and brackets complete	1,500.00
One spare armature	100.00
One spare voltmeter	46.00
One spare ammeter	35.00
One Tyler Rheostadt	50.00
One flashing device	30.00
Five hundred feet No. 14 Grimshaw wire	7.50
Eight No. 1 copper brushes (commutator)	12.00
One spare piston valve	5.00
Two crank brasses and studs (spare)	20.00
Miscellaneous stores and material	147.19
Total	4,217.69

*By contract with Thomson-Houston Company.

The vessel has been consuming coal at the rate of 50 tons a month, using steam from the main boilers for both fog signal and electric lights. As fog occurs but a small proportion of the total time, the expenditure by main boilers is necessarily quite wasteful for running only one small 8-horse power engine for the dynamo. The auxiliary boiler fitted in the vessel, designed and built to run the steam windlass and heat vessel only, is not of sufficient power to run one of the dynamo engines.

The vessel was placed on her station December 15, 1892, has been moored with single cable and will be moored with bridle this winter. The total amount of coal furnished this vessel up to July 1, 1893, is 211.8 tons. The first of July, 1893, the bunkers contained 34.9 tons; total consumption, therefore, 176.9 tons. Of this amount 27.3 tons have been consumed in running the fog signal, and 149.6 tons for running the electric plant, galley, etc. The lanterns and electric plant have worked satisfactorily since the vessel was placed on her station.

The amount of coal consumed up to July 1, 1893, is 176.9 tons; taking the average price paid, or $4.45 per ton, the cost of fuel will be $787.20.

This vessel received during the year electric supplies, engineers' tools, medicines, lamps, hose, bedding, and provisions at the following cost:

Incidental supplies	$1,205.18
Repairs	127.00
Wages	4,928.10
Rations	701.07
Shipchandlery	224.28
Engineers' stores	1,113.74
Electric supplies and lamps	3,754.03
	12,053.40
Coal as above	787.20
Total	12,840.60

Very respectfully,

W. S. SCHLEY,
Captain, U. S. N.,
Inspector Third Light-House District.

The LIGHT-HOUSE BOARD,
Washington, D. C.

REPORT OF THE LIGHT-HOUSE BOARD.

APPENDIX No. 4.

REPORT

UPON THE

REVOLVING LIGHT ON THE SANDY HOOK LIGHT-VESSEL

BY

WINFIELD S. SCHLEY, CAPTAIN, U. S. NAVY,

Inspector, Third Light-House District.

THE REVOLVING LIGHT ON THE SANDY HOOK LIGHT-VESSEL.

OFFICE OF INSPECTOR, THIRD DISTRICT,
Tompkinsville, N. Y., October 16, 1893.

SIRS: In reply to the Board's letter of October 11, 1893, I have the honor to submit the following report of the fitment, workings, etc., of the revolving light on board the Sandy Hook light-vessel:

In 1874 were received at the U. S. General Light-House Depot from De Ville & Co. of London, England, two "revolving floating lights" for use on board light-vessels. These lights were not utilized until August, 1891, when one was fitted to the new light-vessel No. 48, now stationed off Sandy Hook, N. J.

In April, 1892, the other English lantern was fitted to Relief light-vessel No. 16, held in reserve at this depot. The general method of fitment and operation is as follows:

In both light-vessels the revolving light is fitted to the foremast, while on the mainmast is placed the ordinary light-vessel lantern for a fixed light. Both the fixed and revolving lanterns, when not in use, are lowered into deck houses fitted with lifting roofs, as is customary with all light-vessels.

To put the revolving light into operation, the lantern is hoisted in the usual manner, by chains leading to a deck winch. When the lantern reaches its normal height on the foremast, the chariot (on which hang 9 mineral oil lamps) engages by a system of cog wheels with a single metallic shaft running up and secured to the after side of the foremast. The 9 mineral oil lamps (which are of the ordinary constant level type) are arranged in 3 groups of 3 lamps each, so that when the chariot revolves, upon which they hang, a flash of light is produced towards the various segments of the horizon, there being a dark space between the different groups.

Various motors for revolving the chariot inside the lantern were experimented with before the vessel was placed on its station (see the annual report of Major D. P. Heap, Corps of Engineers U. S. Army, for 1892). Compressed air, electricity, and hot air all presented difficulties of application or danger so that no one of these was adopted. Clockwork actuated by a very heavy weight was finally fitted for turning the vertical shaft on the mast, and the light was so revolved for some months after the vessel was first placed on its station off Sandy Hook. But the great weight required, together with the number of right-angle leads for wire rope, etc., rendered necessary by the contracted limits of the vessel, and the fact that the weights had to be wound up every twenty minutes for effective revolution of light, rendered this system cumbersome and undesirable.

A solution of the difficulty was finally found in the adoption of a small pair of steam engines, made for turning the windlass of a yacht.

These little engines, which require only about 10 pounds of steam for effective operation, are bolted to the underside of the deck beams supporting the forward lantern, and are well out of the way of work carried on about the deck, as well as being protected from the weather. They actuate the vertical shaft to the chariot of the

lamps, and the revolutions are controlled by a small governor. A pair of engines with governor and worm-gear complete, cost about $220.00. These engines have worked efficiently on board these two light-vessels, Nos. 48 and 16, and require but little attention.

The characteristic of the revolving light of Sandy Hook light-vessel is flashing red every thirty seconds. The red light is produced in the usual manner by red chimneys placed on the 9 lamps hanging on chariot. At the same time, there is a fixed red light on the mainmast of Sandy Hook light-vessel.

The revolving light on this vessel is held in high estimation by mariners considered a great improvement over the fixed red lights on both masts, whi in use on board Sandy Hook light-vessel for a great number of years.

Very respectfully,

W. S. SCHLE

Captain, U. S. Navy, Ins

The LIGHT-HOUSE BOARD,

Washington, D. C.

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ANNUAL REPORT

OF THE

LIGHT-HOUSE BOARD

TO THE

SECRETARY OF THE TREASURY

FOR THE

FISCAL YEAR ENDED JUNE 30, 1894.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

ANNUAL REPORT

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LIGHT-HOUSE BOARD

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1894.

TREASURY DEPARTMENT,
Document No. 1722.
Office of Light-House Board.

LIGHT-HOUSE BOARD OF THE UNITED STATES.

Organized in conformity to the act of Congress approved August 31, 1852.

LIST OF MEMBERS ON JULY 1, 1894.

Hon. JOHN G. CARLISLE, Secretary of the Treasury, *ex officio* president.
Mr. WALTER S. FRANKLIN.
Prof. THOMAS C. MENDENHALL, Superintendent of the U. S. Coast and Geodetic Survey.
Rear-Admiral JAMES A. GREER, U. S. Navy.
Capt. ROBLEY D. EVANS, U. S. Navy.
Col. JOHN M. WILSON, Corps of Engineers, U. S. Army.
Capt. GEORGE DEWEY, U. S. Navy.
Maj. HENRY M. ADAMS, Corps of Engineers, U. S. Army.
Capt. PHILIP M. PRICE, Corps of Engineers, U. S. Army.

EXECUTIVE MEMBERS OF THE BOARD

Chairman.—Rear-Admiral JAMES A. GREER, U. S. Navy.
Naval Secretary.—Capt. ROBLEY D. EVANS, U. S. Navy.
Engineer Secretary.—Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army, to February 28, 1894; Capt. PHILIP M. PRICE, Corps of Engineers, U. S. Army, from March 9, 1894.

OFFICERS IN CHARGE OF LIGHT-HOUSE DISTRICTS.

FIRST DISTRICT.

Inspector.—Commander GEORGE E. WINGATE, U. S. Navy, Portland, Me.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

SECOND DISTRICT.

Inspector.—Commander GEORGE F. F. WILDE, U. S. Navy, to November 30, 1893; Commander FRANCIS M. GREEN, U. S. Navy, Boston, Mass., from November 30, 1893.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

THIRD DISTRICT.

Inspector.—Capt. WINFIELD S. SCHLEY, U. S. Navy, Tompkinsville, N. Y.
Engineer.—Maj. DAVID P. HEAP, Corps of Engineers, U. S. Army, Tompkinsville, N. Y.

FOURTH DISTRICT.

Inspector.—Commander PURNELL F. HARRINGTON, U. S. Navy, to July 15, 1893; Commander GEORGE C. REITER, U. S. Navy, Philadelphia, Pa., from July 15, 1893.
Engineer.—Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army, to February 24, 1894; Maj. CHARLES W. RAYMOND, Corps of Engineers, U. S. Army, Philadelphia, Pa., from February 24, 1894.

FIFTH DISTRICT.

Inspector.—Commander YATES STIRLING, U. S. Navy, Baltimore, Md.

Engineer.—Capt. ERIC BERGLAND, Corps of Engineers, U. S. Army, Baltimore, Md.

SIXTH DISTRICT.

Inspector.—Commander MORRIS R. S. MACKENZIE, U. S. Navy, Charleston, S. C.

Engineer.—Capt. ERIC BERGLAND, Corps of Engineers, U. S. Army, Baltimore, Md.

SEVENTH DISTRICT.

Inspector.—Commander WILLIAM B. NEWMAN, U. S. Navy, Pensacola navy-yard, Fla.

Engineer.—Maj. JAMES B. QUINN, Corps of Engineers, U. S. Army, New Orleans, La.

EIGHTH DISTRICT.

Inspector.—Commander DENNIS W. MULLAN, U. S. Navy, to February 28, 1894; Commander JOSEPH B. COGHLAN, U. S. Navy, New Orleans, La., from February 28, 1894.

Engineer.—Maj. JAMES B. QUINN, Corps of Engineers, U. S. Army, New Orleans, La.

NINTH DISTRICT.

Inspector.—Commander JOHN J. BRICE, U. S. Navy, to February 15, 1894; Commander WILLIAM W. MEAD, U. S. Navy, to May 1, 1894; Commander JAMES H. DAYTON, U. S. Navy, Chicago, Ill., from May 1, 1894.

Engineer.—Maj. MILTON B. ADAMS, Corps of Engineers, U. S. Army, Detroit, Mich.

TENTH DISTRICT.

Inspector.—Commander JAMES G. GREEN, U. S. Navy, Buffalo, N. Y.

Engineer.—Lieut. Col. JARED A. SMITH, Corps of Engineers, U. S. Army, Cleveland, Ohio.

ELEVENTH DISTRICT.

Inspector.—Commander WILLIAM W. MEAD, U. S. Navy, Detroit, Mich.

Engineer.—Maj. MILTON B. ADAMS, Corps of Engineers, U. S. Army, Detroit, Mich.

TWELFTH DISTRICT.

Inspector.—Commander HENRY E. NICHOLS, U. S. Navy, San Francisco, Cal.

Engineer.—Maj. WILLIAM H. HEUER, Corps of Engineers, U. S. Army, San Francisco, Cal.

THIRTEENTH DISTRICT.

Inspector.—Commander OSCAR W. FARENHOLT, U. S. Navy, Portland, Oreg.

Engineer.—Maj. THOMAS H. HANDBURY, Corps of Engineers, U. S. Army, to November 30, 1893; Maj. JAMES C. POST, Corps of Engineers, U. S. Army, Portland, Oreg., from February 19, 1894.

FOURTEENTH DISTRICT.

Inspector.—Lieut. Commander F. W. CROCKER, U. S. Navy, Cincinnati, Ohio.

Engineer.—Lieut. Col. AMOS STICKNEY, Corps of Engineers, U. S. Army, Cincinnati, Ohio.

FIFTEENTH DISTRICT.

Inspector.—Commander WILLIAM C. WISE, U. S. Navy, to June 1, 1894; Lieut. Commander ABRAHAM B. H. LILLIE, U. S. Navy, St. Louis, Mo., from June 1, 1894.

Engineer.—Lieut. Col. CHARLES R. SUTER, Corps of Engineers, U. S. Army, St. Louis, Mo.

SIXTEENTH DISTRICT.

Inspector.—Commander ANDREW J. IVERSON, U. S. Navy, Memphis, Tenn.

Engineer.—Lieut. Col. CHARLES R. SUTER, Corps of Engineers, U. S. Army, St. Louis, Mo.

REPORT

OF

THE UNITED STATES LIGHT-HOUSE BOARD.

TREASURY DEPARTMENT,
OFFICE OF THE LIGHT-HOUSE BOARD,
Washington, D. C., November 7, 1894.

SIR: The Light-House Board has the honor to submit, for your information and that of Congress, the following report of the work done under its direction during the fiscal year which ended on June 30, 1894.

At the close of the year there were under the control of the Light-House Establishment the following-named aids to navigation:

Light-houses and beacon lights, not including the 372 post lights in the Third, Fourth, Fifth, Sixth, Eighth, Eleventh, Twelfth, and Thirteenth light-house districts	953
Light-ships in position	40
Light-ships for relief	5
Electric buoys in position	7
Gas buoys in position	9
Fog signals operated by steam or hot air	125
Fog signals operated by clockwork	187
Post lights on the Western rivers	1,405
Post lights on other rivers	372
Day or unlighted beacons	414
Whistling buoys in position	66
Bell buoys in position	92
Other buoys in position, including pile buoys and stakes in Fifth district and buoys in Alaskan waters	4,434

In the construction, care, and maintenance of these aids to navigation there were employed:

Steam tenders	32
Steam launches	6
Sailing tenders	2
Light keepers	1,190
Other employés, including crews of light-ships and tenders	880
Laborers in charge of Western river lights	1,146
Laborers in charge of other river post lights	206

NEW LIGHTS.

The following named new lights were established during the fiscal year:

Ballard Reef light-vessel, No. 63, Detroit River, Michigan.—A lens-lantern light, July 1, 1893.

Third Dame Point Cut post light, No. 12, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Fourth Dame Point Cut post light, No. 14, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Fifth Dame Point Cut post-light, No. 16, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Upper Dame Point Cut post light, No. 9, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Oakland Harbor South Jetty, San Francisco Bay, California.—A lens-lantern light, September 15, 1893.

Ashtabula Pierhead range (rear), Lake Erie, Ohio.—A triple lens-lantern light, September 15, 1893.

Limekiln Crossing (south) light-vessel, No. 64, Detroit River, Michigan.—A lens-lantern light, September 15, 1893.

Limekiln Crossing (north) light-vessel, No. 65, Detroit River, Michigan.—A lens-lantern light, September 15, 1893.

Bar Point light-vessel, No. 59, mouth of Detroit River, Michigan.—A triple lens-lantern light, September 18, 1893.

Seavys Island beacon, Portsmouth Harbor, Maine.—A double tubular-lantern light, September 25, 1893.

Lake Huron light-vessel, No. 61, Lake Huron, Michigan.—A triple lens-lantern light, September 25, 1893.

Poe Reef light-vessel, No. 62, Straits of Mackinac, Michigan.—A triple lens-lantern light, September 27, 1893.

Pages Rock, York River, Virginia.—A fourth-order light, September 30, 1893.

Eleven-Foot Shoal light-vessel, No. 60, Green Bay, Michigan.—A triple lens-lantern light, October 6, 1893.

Fairport range (rear), Lake Erie, Ohio.—A triple lens-lantern light, October 15, 1893.

Black River range (rear), Lake Erie, Ohio.—A triple lens-lantern light, October 15, 1893.

Head of the Passes West Jetty, Mississippi River, Louisiana.—A lens-lantern light, October 20, 1893.

Marquette Breakwater (outer end), Lake Superior, Michigan.—A lantern light, October, 1893.

Buoy Depot Wharf post light, Columbia River, Oregon.—A tubular-lantern light, November 1, 1893.

Chicago Harbor, Lake Michigan, Illinois.—A third-order light, November 10, 1893.

Olympia Jetty post light, Puget Sound, Washington.—A tubular-lantern light, November 15, 1893.

Coanjock Bay beacon, Currituck Sound, North Carolina.—A lens-lantern light, November 25, 1893.

Turn Point, Washington Sound, Washington.—A tubular-lantern light, November 30, 1893.

Patos Islands, Washington Sound, Washington.—A tubular-lantern light, November 30, 1893.

Lower Cedar Point, Potomac River, Maryland.—A lens-lantern light, December 29, 1893. (In place of apparatus destroyed by fire.)

Bridgeport Breakwater, Bridgeport Harbor, Connecticut.—A tubular-lantern light, January 31, 1894.

Christiana beacon, Delaware River, Delaware.—A lens-lantern light, January 31, 1894.

March Point post light, Washington Sound, Washington.—A tubular-lantern light, February 2, 1894.

La Conner Jetty post light, Skagit Bay, Washington.—A tubular-lantern light, February 3, 1894.

Rodman Point Shoal beacon, Pamlico River, North Carolina.—A tubular-lantern light, February 28, 1894.

Windmill Point Shoal beacon, Pamlico River, North Carolina.—A tubular-lantern light, February 28, 1894.

Timbalier, Timbalier Bay, Louisiana.—A tubular-lantern light, March 20, 1894. (To replace light destroyed.)

Heceta Head, seacoast of Oregon.—A first-order light, March 30, 1894.

Seavys Island range (front), Portsmouth Harbor, Maine.—A lantern light, April 10, 1894.

Milwaukee post light, Willamette River, Oregon.—A tubular-lantern light, April 15, 1894.

Elk Rock post light, Willamette River, Oregon.—A tubular-lantern light, April 15, 1894.

Clackamas Rapids post light, Willamette River, Oregon.—A tubular-lantern light, April 15, 1894.

Bush Point post light, Admiralty Inlet, Washington.—A tubular-lantern light, May 10, 1894.

Wolf Trap, Chesapeake Bay, Virginia.—A lantern light, April 14, 1894. (On the structure in course of construction.)

Kenosha Pierhead range (front), Lake Michigan, Wisconsin.—A lantern light May 12, 1894.

San Carlos Creek post light, St. Johns River, Florida.—A lantern light, May 20, 1894.

Kalamazoo Pierhead, Lake Michigan, Michigan.—A lantern light, May 23, 1894.

Racine Pierhead, Lake Michigan, Wisconsin.—A lantern light, May 28, 1894.

Volusia Guide Piles post light, St. Johns River, Florida.—A lantern light, May 31, 1894.

Manistee, Lake Michigan, Michigan.—A fifth-order light, June 18, 1894.

Manistee Pierhead range (front), Lake Michigan, Michigan.—A lantern light, June 18, 1894.

NEW FOG SIGNALS.

During the fiscal year fog signals were established at the following-named existing light-stations:

Ashtabula range (front), Lake Erie, Ohio.—A 6-inch steam whistle, September 30, 1893.

Superior Pierhead, Lake Superior, Wisconsin—A 6-inch steam whistle, October 15, 1893.

The following-named new fog signals were established during the fiscal year:

Pages Rock, York River, Virginia.—A bell struck by machinery, September 30, 1893.

Bar Point light-vessel, No. 59, mouth of Detroit River, Michigan.—A 6-inch steam whistle, September 18, 1893.

Lake Huron light-vessel, No. 61, Lake Huron, Michigan.—A 6-inch steam whistle, September 25, 1893.

Poe Reef light-vessel, No. 62, Straits of Mackinac, Michigan.—A 6-inch steam whistle, September 27, 1893.

Eleven-Foot Shoal light-vessel, No. 60, Green Bay, Michigan.—A 6-inch steam whistle, October 6, 1893.

Chicago Harbor, Lake Michigan, Illinois.—A 10-inch steam whistle, November 10, 1893.

Turn Point, Washington Sound, Washington.—A Daboll trumpet, November 30, 1893.

Patos Islands, Washington Sound, Washington.—A Daboll trumpet, November 30, 1893.

LIGHTS DISCONTINUED.

The following-named lights were, in the course of the last fiscal year, discontinued:

Wreck of the bark Undine, Savannah River, Georgia.—A lantern light, August 23, 1893, the wreck having been removed.

Middle Quarantine Shoal post light, No. 12, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Radcliffe Island post light, No. 16, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Dame Point Middle Ground post light, No. 18, St. Johns River, Florida.—A tubular-lantern light, August 15, 1893.

Oakland Harbor range (rear), San Francisco Bay, California.—A lens-lantern light, September 12, 1893.

Battery Island post light, No. 3, Cape Fear River, North Carolina.—A tubular-lantern light, November 2, 1893.

Chicago River, Lake Michigan, Illinois.—A third-order light, November 10, 1893.

Chicago Outer Breakwater (SE. end). Lake Michigan, Illinois.—A double lens-lantern light, November 10, 1893.

West Olympia post light, Puget Sound, Washington.—A tubular-lantern light, November 15, 1893.

Lower Cedar Point, Potomac River, Maryland.—A fifth-order light, December 25, 1893. (Light-house destroyed by fire.)

Timbalier, Timbalier Bay, Louisiana.—A second-order light, January 29, 1894. (Light-house destroyed.)

Christiana, Delaware River, Delaware.—A fourth order light, January 31, 1894.

Crandall Spit post light, Washington Sound, Washington.—A tubular-lantern light, February 2, 1894.

Weaverling Spit post light, Washington Sound, Washington.—A tubular-lantern light, February 2, 1894.

Gardiners Island, Gardiners Bay, New York.—A sixth-order light March 8, 1894. (Station undermined by the sea.)

Wing Dam, No. 13, post light, Savannah River, Georgia.—A tubular-lantern light, April 16, 1894.

Lake Beresford post light, No. 108, St. Johns River, Florida.—A tubular-lantern light, May 15, 1894.

Racine Pierhead, Lake Michigan, Wisconsin.—A sixth-order light, May 28, 1894.

Manistee Pierhead range (front), Lake Michigan, Michigan.—A tubular-lantern light, June 18, 1894.

Manistee Pierhead range (rear), Lake Michigan, Michigan.—A sixth-order light, June 18, 1894.

FOG SIGNAL DISCONTINUED.

During the fiscal year the following-named fog signal was discontinued:

Lower Cedar Point, Potomac River, Maryland.—A bell struck by machinery, December 25, 1893. (Station destroyed by fire.)

CHANGES IN LIGHTS.

During the fiscal year the following changes were made in existing lights:

Cob Point Bar, Potomac River, Maryland.—Changed August 15, 1893, from a fixed white light to a fixed white light with a fixed red sector extending from ESE. $\frac{1}{16}$ E. northward to SE. by E. $\frac{1}{8}$ E. (about 10° 30′ of arc).

Lower Cedar Point, Potomac River, Maryland.—Changed August 15, 1893, by extending the fixed red sector of the light to make its southwesterly edge bear N. by W. ⅝ W.

Lower Quarantine Shoal post light, St. Johns River, Florida.—The color of the light was changed from red to white and the number from 10 to 7, August 15, 1893.

Van Sickle Island post light, entrance to Sacramento River, California.—The height of the light was increased 12 feet, August 3, 1893.

Tarrytown, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Livingston Creek post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Catskill (West Flat) post light, Hudson River, New York.—The color of the light was changed from red to white, September 30, 1893.

Coxsackie East Flats, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Stuyvesant, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Sand Spit, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

New Baltimore Dike post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Five-Hook Island post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Schodack Channel post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Nine-Mile Tree post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Cow Island post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Cuyler Dike post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Bath Dike post light, Hudson River, New York.—The color of the light was changed from white to red, September 30, 1893.

Old Maid Place, Whitehall Narrows, Vermont.—The number of the light was changed from 16 to 1, September 30, 1893.

Lower end of Four Channels and Narrows, Whitehall Narrows, New York.—The color of the light was changed from white to red and the number from 15 to 2, September 30, 1893.

Pulpit Point light, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 14 to 4, September 30, 1893.

Above Pulpit Point, Whitehall Narrows, Vermont.—The number of the light was changed from 13 to 3, September 30, 1893.

Opposite Belden Dock, Whitehall Narrows, Vermont.—The number of the light was changed from 12 to 5, September 30, 1893.

Chilson Bend, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 11 to 6, September 30, 1893.

Lower end of Two Channels, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 9 to 8, September 30, 1893.

Maple Bend, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 8 to 10, September 30, 1893.

Head of Two Channels, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 7 to 12, September 30, 1893.

Long Reach, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 6 to 14, September 30, 1893.

Steam-Mill Point, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 5 to 16, September 30, 1893.

South of Snody Dock, Whitehall Narrows, Vermont.—The number of the light was changed from 4 to 7, September 30, 1893.

Opposite Chapman Dock, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 3 to 18, September 30, 1893.

Carey Camp, Whitehall Narrows, New York.—The color of the light was changed from white to red, and the number from 2 to 20, September 30, 1893.

Benjamin Place, Whitehall Narrows, Vermont.—The number was changed from 1 to 9, September 30, 1893.

Chandeleur, Chandeleur Sound, Louisiana.—Changed from a fourth-order light to a tubular-lantern light, October 1, 1893. (Structure destroyed in gale of October 1, 1893.)

Oak Island range (front), mouth of Cape Fear River, North Carolina.—Changed from a sixth-order light, 22 feet high, to a tubular-lantern light, 18 feet high, October 12, 1893. (Structure destroyed in gale of October 12, 1893.)

South San Francisco range (front), San Francisco Bay, California.—Changed from a fixed white to a fixed red light, October 30, 1893.

Tortugas Harbor, Garden Key, Florida.—The southerly edge of the westerly red sector of the light was corrected, December 15, 1893, to bear NE. by E. $\frac{1}{4}$ E. and to intersect the southeasterly edge of the red sector of Dry Tortugas light at a point about $3\frac{3}{8}$ miles from the latter light.

Dumpling Rock, Buzzards Bay, Massachusetts.—The light was changed, December 22, 1893, from fixed white to fixed white with a fixed red sector. The red sector extends from NE. $\frac{1}{2}$ N. northwestwardly to NE. $\frac{3}{4}$ E. and covers Mishaum Ledge.

TREASURY DEPARTMENT,
Document No. 1722.
Office of Light-House Board.

LIGHT-HOUSE BOARD OF THE UNITED STATES.

Organized in conformity to the act of Congress approved August 31, 1852.

LIST OF MEMBERS ON JULY 1, 1894.

Hon. JOHN G. CARLISLE, Secretary of the Treasury, *ex officio* president.
Mr. WALTER S. FRANKLIN.
Prof. THOMAS C. MENDENHALL, Superintendent of the U. S. Coast and Geodetic Survey.
Rear-Admiral JAMES A. GREER, U. S. Navy.
Capt. ROBLEY D. EVANS, U. S. Navy.
Col. JOHN M. WILSON, Corps of Engineers, U. S. Army.
Capt. GEORGE DEWEY, U. S. Navy.
Maj. HENRY M. ADAMS, Corps of Engineers, U. S. Army.
Capt. PHILIP M. PRICE, Corps of Engineers, U. S. Army.

EXECUTIVE MEMBERS OF THE BOARD

Chairman.—Rear-Admiral JAMES A. GREER, U. S. Navy.
Naval Secretary.—Capt. ROBLEY D. EVANS, U. S. Navy.
Engineer Secretary.—Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army, to February 28, 1894; Capt. PHILIP M. PRICE, Corps of Engineers, U. S. Army, from March 9, 1894.

OFFICERS IN CHARGE OF LIGHT-HOUSE DISTRICTS.

FIRST DISTRICT.

Inspector.—Commander GEORGE E. WINGATE, U. S. Navy, Portland, Me.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

SECOND DISTRICT.

Inspector.—Commander GEORGE F. F. WILDE, U. S. Navy, to November 30, 1893; Commander FRANCIS M. GREEN, U. S. Navy, Boston, Mass., from November 30, 1893.
Engineer.—Maj. WILLIAM R. LIVERMORE, Corps of Engineers, U. S. Army, Boston, Mass.

THIRD DISTRICT.

Inspector.—Capt. WINFIELD S. SCHLEY, U. S. Navy, Tompkinsville, N. Y.
Engineer.—Maj. DAVID P. HEAP, Corps of Engineers, U. S. Army, Tompkinsville, N. Y.

FOURTH DISTRICT.

Inspector.—Commander PURNELL F. HARRINGTON, U. S. Navy, to July 15, 1893; Commander GEORGE C. REITER, U. S. Navy, Philadelphia, Pa., from July 15, 1893.
Engineer.—Capt. FREDERICK A. MAHAN, Corps of Engineers, U. S. Army, to February 24, 1894; Maj. CHARLES W. RAYMOND, Corps of Engineers, U. S. Army, Philadelphia, Pa., from February 24, 1894.

drawn from the station and replaced by the schooner *Drift* December 10, 1893. Schooner *Drift* withdrawn and light-vessel No. 46, with steam fog whistle repaired, replaced on the station March 16, 1894.

Bush Bluff light-vessel, Elizabeth River, Virginia.—Schooner *Drift* withdrawn from the station and replaced by the light-house tender *Holly*, August 5, 1893. Light-house tender *Holly* withdrawn and replaced by the schooner *Drift*, October 5, 1893. Schooner *Drift*, damaged by collision, withdrawn from the station and replaced by the light-house tender *Holly*, October 16, 1893.

Morris Island south range (front), entrance to Charleston Harbor, South Carolina.—Beacon washed away in the gale of August 27, 1893; reestablished September 6, 1893.

Morris Island north range (front), entrance to Charleston Harbor, South Carolina.—Beacon washed away in the gale of August 27, 1893; reestablished September 6, 1893.

Tybee beacon, entrance to Savannah River, Georgia.—Beacon overturned in the gale of August 27, 1893; reestablished September 6, 1893.

Rattlesnake Shoal light-vessel No. 34, off the entrance to Charleston Harbor, South Carolina.—Wrecked in the storm of August 27, 1893. Replaced by light-vessel No. 29, September 1, 1893. Light-vessel No. 29 withdrawn and light-vessel No. 34 replaced May 31, 1894.

Wolf Island range (front), entrance to Doboy Sound, Georgia.—Beacon carried away by the storm of August 27, 1893; reestablished temporarily. Rebuilt June, 1894.

Fishers Point range (front) post light, Delaware River, New Jersey.—Carried away in the storm of August 29, 1893. Rebuilt September 4, 1893.

Hen and Chickens light-vessel No. 2, entrance to Buzzards Bay, Massachusetts.—Withdrawn from the station for repairs and replaced by relief light vessel No. 9, September 1, 1893. Relief light-vessel No. 9 withdrawn and light-vessel No. 2 replaced October 12, 1893.

St. George Reef, off the seacoast of California.—Owing to the scarcity of water the working of the fog signal was reduced to sounding the characteristic signal during periods of 5 minutes, separated by silent intervals of 10 minutes, from September 1, 1893, to October 1, 1893.

Cornfield Point light-vessel No. 51, Long Island Sound, Connecticut.—Withdrawn from the station for repairs and replaced by light-vessel No. 23, October 20, 1893. Light-vessel No. 23 withdrawn and light-vessel No. 51 replaced, November 1, 1893.

Cape Canaveral, seacoast of Florida.—The first-order light, flashing white every minute, was discontinued and replaced by a fourth-

order light, flashing white every 10 seconds, in a temporary structure, October 23, 1893. The fourth-order light will be exhibited during the removal and reerection of the station at a point 5,200 feet S. 87° 24′ W. (W. ¼ S.) from its former location. (First-order light reestablished July 25, 1894.)

Frying-Pan Shoals light-vessel No. 53, off the seacoast of North Carolina.—Withdrawn from the station for repairs and replaced by light-vessel No. 34, December 28, 1893. Light-vessel No. 34 withdrawn and light-vessel No. 53 replaced, February 19, 1894.

Wreck of the barge Milton, East River, New York.—A tubular-lantern light, to mark the wreck, was established January 11, 1894, and discontinued January 23, 1894.

Pumpkin Island, Eggemoggin Reach, Maine.—Discontinued on account of ice, February 26, 1894; reestablished March 5, 1894.

Browns Head, entrance to Fox Island Thoroughfare, Maine.—Discontinued on account of ice, February 26, 1894; reestablished March 3, 1894.

Wing Dam No. 13 post light, Savannah River, Georgia.—Destroyed by collision January 21, 1894; reestablished February 15, 1894.

Dame Point Dredged Cut post light, No. 16, St. Johns River, Florida.—Destroyed by collision February 20, 1894; reestablished March 12, 1894.

Apalachicola Bay range (front), Apalachicola Bay, Florida.—Wrecked February 16, 1894; reestablished February 20, 1894.

Great Marsh Island Shoal post light, No. 1, St. Johns River, Florida.—Destroyed by collision March 14, 1894; reestablished March 21, 1894.

Minots Ledge, off the entrance to Boston Harbor, Massachusetts.—Six lens-lantern lights displayed from April 22 to May 1, 1894, during the taking down of the former and erection of the new illuminating apparatus.

Winter-Quarter Shoal light-vessel, off the seacoast of Virginia.—Steam fog signal discontinued for repairs and bell struck by hand, substituted April 26, 1894, until further notice.

Bartlett Reef light-vessel No. 13, Long Island Sound, Connecticut.—Withdrawn from the station for repairs and replaced by relief light-vessel No. 20 May 1, 1894. (Relief light-vessel No. 20 withdrawn and light-vessel No. 13 replaced July 19, 1894.)

Southwest Pass, entrance to the Mississippi River, Louisiana.—Damaged by fire and light extinguished May 22, 1894. Light reestablished June 4, 1894.

New Channel range (front) post light, Cape Fear River, North Carolina.—A light, screened to seaward, was shown from the new structure pending the removal to the same of the light from the old structure.

Superior Bay Channel (lower middle) post light, Superior Bay, Minnesota.—Structure wrecked by collision. Hand lantern displayed on wreck from June 5, 1894, until July 1, 1894, when the structure was rebuilt and the regular light reestablished.

Superior Bay Channel (upper) post light, Superior Bay, Minnesota.—Structure wrecked by collision. Hand lantern displayed on wreck from June 10, 1894, until June 28, 1894, when the structure was rebuilt and the regular light reestablished.

Dame Point Cut post light, No. 9, St. Johns River, Florida.—Structure destroyed by collision June 10, 1894; reestablished August 30, 1894.

Wreck of "Canonicus," Kill van Kull, New York.—A tubular-lantern light from June 21, 1894, to July 12, 1894.

Black River range (rear), Lake Erie, Ohio.—Structure destroyed by collision and light discontinued June 22, 1894; reestablished August 25, 1894.

NEW BUOYS.

During the fiscal year the following-named special buoys were established:

Sewall Point, Hampton Roads, Virginia.—An experimental bell buoy, August 7, 1893.

Absecon Inlet, seacoast of New Jersey.—A bell buoy, September 27, 1893.

Brazos River, entrance to Brazos River, Texas.—A whistling buoy, October 15, 1893.

Harding Ledge, entrance to Boston Harbor, Massachusetts.—A gas-lighted buoy, November 8, 1893.

North end of Centurion, entrance to Boston Harbor, Massachusetts.—A gas-lighted buoy, November 8, 1893.

Nix Mate, entrance to Boston Harbor, Massachusetts.—A gas-lighted buoy, January 15, 1894.

Sarah Ledge, off the entrance to New London Harbor, Connecticut.—A bell buoy, February 17, 1894.

Tillamook Bar, off the entrance to Tillamook Bay, Oregon.—A whistling buoy, February 24, 1894.

Crescent City, Crescent City Harbor, California.—A bell buoy, April 24, 1894.

Newport News Middle Ground (SE. side), Hampton Roads, Virginia.—An experimental bell buoy, April 28, 1894.

Newport News Middle Ground (N. side), Hampton Roads, Virginia.—An experimental bell buoy, April 28, 1894.

Elbow of Ledge, Delaware Bay, Delaware.—A gas-lighted buoy, May 24, 1894.

Gardiners Island, Gardiners Bay, New York.—A gas-lighted buoy, May 31, 1894.

White Island Ledge, Isles of Shoals, New Hampshire.—A bell buoy, June 2, 1894. (Established as a permanent aid).

Little Captain Island East Reef, Greenwich Cove, Connecticut.—A gas-lighted buoy, June 26, 1894.

Jones Rocks, Greenwich Cove, Connecticut.—A gas-lighted buoy, June 26, 1894.

BUOYS DISCONTINUED.

During the fiscal year the following-named special buoys were discontinued:

Wolf Trap, Chesapeake Bay, Virginia.—A gas-lighted buoy, June 30, 1893.

World's Fair buoyage, Chicago Harbor, Illinois.—Thirteen electric-lighted buoys, November 9, 1893.

Staniford Ledge, Portland Harbor, Maine.—A Close bell buoy, December, 1893.

Channel, Chesapeake Bay, Virginia.—A bell buoy, December, 1893.

North River Bar, North River, North Carolina.—A bell buoy, December, 1893.

Egg Rock, Frenchman Bay, Maine.—A whistling buoy, February, 1894.

Aids to navigation maintained by the Light-House Board, June 30, 1894.

Aids.	First district.	Second district.	Third district.	Fourth district.	Fifth district.	Sixth district.	Seventh district.	Eighth district.	Ninth district.	Tenth district.	Eleventh district.	Twelfth district.	Thirteenth district.	Fourteenth district.	Fifteenth district.	Sixteenth district.	Atlantic coast.	Pacific coast.	Lake coast.	Western rivers.	Total entire coast, 1893.	Total entire coast, 1894.	Increase or decrease.
Electric lights	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	4	2	−2
First-order lights	2	4	6	5	6	6	8	2	....	....	....	9	8	....	....	....	39	17	....	....	56	56	....
Second-order lights	7	3	1	....	....	1	....	3	1	....	2	1	....	....	....	....	15	1	3	....	20	19	−1
Third-order lights	6	1	5	3	....	4	5	3	7	6	8	3	1	....	....	....	27	4	21	....	52	52	....
Three-and-a-half-order lights	....	2	....	....	....	....	1	....	3	....	4	....	....	....	....	....	3	....	7	....	10	10	....
Fourth-order lights	10	23	37	14	41	9	6	13	33	23	81	10	7	....	....	....	150	17	90	....	205	206	1
Fifth-order lights	24	16	20	7	22	4	1	14	13	6	14	5	2	....	....	....	105	7	36	....	148	148	....
Sixth-order lights	1	5	31	3	11	6	1	2	19	20	12	....	....	....	....	....	51	....	60	....	116	111	−5
Lens lanterns	2	1	5	1	20	6	12	1	4	9	41	4	8	....	....	....	47	12	55	....	124	114	−10
Range lenses	....	....	6	8	2	....	....	....	....	....	....	....	....	....	....	....	16	....	....	....	16	16	....
Reflectors	....	10	....	8	4	14	....	1	....	8	....	....	....	....	....	....	37	....	8	....	45	45	....
Tubular and other lanterns	3	4	126	7	9	153	....	27	17	2	46	7	79	530	523	352	306	86	88	1,405	1,845	1,885	40
Light-vessels in position	....	9	7	4	3	3	....	2	4	4	3	....	1	....	....	....	28	1	11	....	33	40	7
Electric buoys	....	....	7	....	....	....	....	....	....	....	....	....	....	....	....	....	7	....	....	....	20	7	−13
Gas buoys	....	5	3	1	....	....	....	....	....	....	....	....	....	....	....	....	9	....	....	....	2	9	7
Total lighted aids	64	84	255	61	118	206	34	68	101	78	161	39	106	530	523	352	851	145	379	1,405	2,756	2,780	24
Fog signals operated by steam or hot air	13	9	10	6	3	2	....	1	21	6	23	15	10	....	....	....	50	25	50	....	114	125	11
Fog signals operated by clock-work	17	10	50	7	64	3	....	11	7	3	4	7	3	....	....	....	161	10	15	....	189	186	−3
Day beacons	104	72	41	5	9	40	36	13	....	....	1	54	37	....	....	....	320	91	1	....	419	412	−7
Whistling buoys	10	12	5	4	1	6	3	4	....	....	....	12	9	....	....	....	45	21	....	....	64	66	2
Bell buoys	16	16	19	6	1	16	5	1	....	....	2	6	4	....	....	....	80	10	2	....	90	92	2
Other buoys	640	508	573	190	1,156	300	251	96	92	144	153	79	256	....	....	....	3,714	335	389	....	4,315	4,438	123
Total unlighted aids	800	627	704	218	1,234	367	295	126	120	153	183	173	319	....	....	....	4,370	492	457	....	5,191	5,319	128
Total number of aids	864	711	959	279	1,352	573	329	194	221	231	344	212	425	530	523	352	5,221	637	836	1,405	7,947	8,090	152

Appropriations made at the second session of the Fifty-third Congress for light-house purposes.

GENERAL.

Supplies of light-houses	$385,000.00
Repairs of light-houses	490,000.00
Salaries of light-keepers	680,000.00
Expenses of light-vessels	250,000.00
Expenses of buoyage	376,000.00
Expenses of fog signals	70,000.00
Expenses of Board inspecting lights, etc	2,500.00
Lighting rivers	300,000.00
Survey of light-house sites	1,000.00
Total	2,554,500.00

SPECIAL WORKS.

Absecon Inlet, New Jersey	1,200.00
Baltimore light and fog-signal station, Maryland	60,000.00
Big Bay Point light and fog-signal station, Michigan	25,000.00
Boston Harbor light-ship, Massachusetts	35,000.00
Bridgeport light-station, Connecticut	2,500.00
Cape Arago, Oregon	(*)
Cape May, New Jersey	500.00
Chandeleur light-station, Louisiana	35,000.00
Devils Island light-station, Wisconsin	283.94
Forty-Mile Point light and fog signal, Michigan	25,000.00
Grassy Island range lights, Michigan	1,500.00
Grassy Point range lights, Ohio	2,000.00
Hay Lake Channel, Michigan	43,550.00
Hog Island light-station, Virginia	75,000.00
Kewaunee fog signal, Wisconsin	5,500.00
Mobile ship-channel lights, Alabama	30,000.00
North Head light-station, Washington	25,000.00
Oil houses for light-stations	5,000.00
Pere Marquette, Michigan	5,500.00
Round Island, Michigan	15,000.00
Salem Creek, New Jersey	800.00
Sandusky Bay range light-station, Ohio	25,000.00
Seul Choix Pointe light-station, Michigan	(*)
Seul Choix Pointe light and fog signal, Michigan	2,200.00
South Bass Island light-station, Ohio	8,600.00
South Boston range lights, Massachusetts	1,000.00
South Pass light-ship, Louisiana	(*)
Staten Island light-house depot, New York	25,000.00
Tampa Bay, Florida	1,670.81
Two-Bush Island light and fog signal, Maine	19,000.00
Umpqua River light-station, Oregon	2,371.00
Willamette River light and fog signal, Oregon	6,000.00
Total	484,175.75

* Authority.

A detailed statement of the work done in each of the sixteen light-house districts is made in the body of the report, under specified headings, from which it will be evident that the Board has brought the numerous and varied aids to navigation under its charge up to the proper standard, and that it has done all that was possible, with the funds provided, to meet the requirements of commerce and navigation.

THE PROHIBITION OF PRIVATE LIGHTS.

The following recommendation, which has been made in many previous annual reports, is renewed:

The Board renews its recommendations that proper steps be taken to prohibit the establishment or maintenance of private lights and buoys in the navigable waters of the United States except with the consent of the Board, and it again asks that provisions be made to enable it to establish inexpensive and temporary lights in case of exigency and pending the action of Congress. In this connection the Board begs leave to repeat the recommendation made in its annual report for 1883:

"Some action should be taken relative to the establishment of lights and buoys by steamboat companies and other private parties, simply for their own convenience. The Board can not establish a light without special authority of law in each case. It never exhibits a light without previously issuing a formal notice to mariners, and it never extinguishes one without giving similar notice sufficiently in advance to inform all concerned. Private lights are established and extinguished without such notice, much to the annoyance of mariners, who are confused and misled by irregular beacons. Besides this, the lights not being properly kept, go out from time to time.

"One of the best of these private lights is that exhibited from Blackwells Island by the municipality of New York City. It has gone out a number of times recently, and so much to the inconvenience, if not danger, of mariners that complaint has been made and the Board has been subjected to unmerited criticism for failing to do what was alleged to be its duty, when in fact it has not the slightest control over that light. Under these circumstances the Board suggests that the exhibition of lights and the placing of buoys by corporations or private parties be prohibited by law. Lest any interest should suffer thereby it is further suggested that the Board, on being satisfied that it is immediately necessary to do so, be authorized to establish inexpensive temporary lights, if necessary, on leased land, and to pay for their erection and maintenance, together with the cost of employing laborers to act as keepers as is now done on the Western rivers, from the general appropriations for the support of the Light-House Establishment, provided that funds can be spared from them for that purpose, and further provided that the Board shall make report of its actions in each case, with the reason therefor, so that Congress may decide as to the continuance of each light."

OIL HOUSES.

The Board again recommends that appropriation be made for the erection of small, inexpensive structures near to, but separate from, light-houses, in which to keep a year's supply of mineral oil, the illuminant now used by the Light-House Establishment. Last year the Board estimated that $15,000 could be expended with great advantage during the year among the larger, more isolated, and more important light-stations. An appropriation of $5,000 was made for that purpose, which will be expended during the current year.

It is estimated that $15,000 will be needed and can be profitably expended in building oil houses during the coming fiscal year, and the appropriation of that amount is therefore recommended.

The recommendation made in the annual report for each of the last eight years was accompanied by the following explanation:

The substitution of mineral oil for lard oil in the light-house service, which has been in progress for several years, is now finished. As the quantity of the oil now used is larger, and as its bulk is greater than was that of the oil formerly used, and as the mineral oil is much more likely to occasion fire, and indeed to take fire, than was the lard oil, the Board has come to the conclusion, in the interest of safety, to advise that the proper steps be taken to have a house erected at each of the larger stations from a plan specially devised after a careful study for the purpose.

THE LOWEST BID.

The following recommendation, which was made in the Board's annual report for each year since 1887, is renewed:

The Board calls attention to the hampered condition in which it is left by that provision of law which requires the Board to accept the lowest bid to do work for which it has advertised for proposals, no matter how unfit the bidder or how impossible it may be for him to do good work, provided he can give a good bond. It has repeatedly happened that under this clause the Board has been forced to contract with persons who had no proper plant to do the work; with persons who, to get the work, had bid far below its proper cost, and with persons who had done poor work for the Board under previous contracts, and in each instance the result was, as was to be expected, poor, unsatisfactory, unreliable work, which it was necessary to begin to repair soon after it was finished.

As an instance of this the Board refers to the case of the steamer *Zizania*, which should have been completed more than a year ago. Eight months after she should have been finished the contractors made an assignment, and the Government was forced to finish the vessel itself. It was then found that much of the work done was of so poor a character that it became necessary to do it over. This added largely to the cost of the vessel and increased the time required for building it. The Board needed the tender at the time the appropriation was made for her construction. It would have had her services more than a year ago if the contract had been let to the best rather than the lowest bidder. The recourse against the sureties of contractors for bad work, as a rule, fails to be effective. In rare cases where a penalty has been exacted it has been made the basis of claims against Congress which have been sometimes prosecuted to a successful issue. But, bad as this is, there is nothing to prevent failing or fraudulent contractors from becoming the lowest bidders for fresh work. In fact, there is nothing under the present state of the law, and the construction given it, to prevent the failing contractors for the tender *Zizania*, bad and late as their work was, from getting the contract for building the new supply ship, for which appropriation has just been made, if they bid low enough and can again provide satisfactory bondsmen. The Board suggests that it may be protected against such evils by appropriate legislation.

The following is the text of section 4667, Revised Statutes:

"No contract for the erection of any light-house shall be made except after public advertisement for proposals in such form and manner as to secure general notice thereof, and the same shall only be made with the lowest bidder therefor, upon security deemed sufficient in the judgment of the Secretary of the Treasury."

It is proposed that this section be modified by adding the following proviso:

Provided, That when, in the opinion of the Secretary of the Treasury, it shall be

detrimental to the interests of the Government to contract with the lowest bidder, he shall contract with the next lowest bidder not subject to similar objections, but the Secretary of the Treasury shall put on record his reasons therefor in each such case in the letter rejecting such lowest bid or bids.

NEW WORKS AUTHORIZED.

Congress authorized by the act approved on January 22, 1894, the establishment of a light and fog signal on or near Butler Flat, entrance to the lower harbor of New Bedford, Mass., at a cost not to exceed $45,000, but no appropriation was made for its construction.

Congress had previously authorized by the act approved on February 15, 1893, the establishment of forty light-stations, at an aggregated cost of $429,800, but no appropriations have been made for their construction. The following is a list of the works thus authorized, with the maximum amount which each may cost:

Galloo Island fog signal, New York	$5,700
Carlton Island light-house, New York	8,600
Bay State Shoal lights, New York	800
Erie Harbor (Presqu'ile) fog signal, Pennsylvania	4,300
Fairport Harbor fog signal, Ohio	4,300
Lorain Harbor (Black River) fog signal, Ohio	4,300
Port Clinton light, Ohio, reestablishing	1,500
Poe Reef light-vessel, Straits of Mackinac, Michigan *	25,000
Grand Marias light and fog signal, Michigan	15,000
Big Sable Point fog signal, Michigan	5,500
Mendota light and fog signal, Michigan	7,500
Eagle Harbor fog signal, Michigan	5,500
Sand Hills light-house, Michigan	20,000
Portage Lake Ship Canal fog signal, Michigan	5,500
Chequamegon light and fog signal, Wisconsin	7,500
Chequamegon Harbor light and bell, Wisconsin	2,500
Devils Island light-station, Wisconsin, completion	22,000
Bayfield light and fog signal, Wisconsin	5,000
Pats (or Hat) Point light and fog signal, Minnesota	15,000
South Fox Island fog signal, Michigan	5,500
North Manitou light and fog signal, Michigan	20,000
Ludington light and fog-signal station, Michigan, keeper's dwelling	4,500
St. Joseph fog signal, Michigan	5,000
Manitowoc fog signal, Wisconsin	5,500
Sturgeon Bay Canal light, Wisconsin	20,000
Porte des Morts range lights and fog signal, Michigan	21,000
St. Martin Island light, Michigan	15,000
Little Gull Island light and fog signal, Michigan	20,000
Squaw Point (Gladstone) light, Michigan	5,000
Peshtigo Shoal light and fog signal, Wisconsin	10,000
Sheboygan fog signal, Wisconsin	5,500
Southwest Ledge fog signal, Connecticut	12,500
Wilson Harbor light, New York	2,500
Big Oyster Bed Shoal light and fog signal, New Jersey	25,000
Deer Point light, Florida	1,000

* A cheaply built light-vessel has been placed on Poe Reef pending the passage of this appropriation.

Grays Harbor light and fog signal, Washington	$60,000
New York Slough light and fog signal, California	10,000
Mermenteau River light, Louisiana	7,000
Willamette River, Oregon, 25 beacon lights and buoys between Salem and Portland	5,000
Tibbetts Point fog signal, New York	4,300

LIGHTING BRIDGES.

The following recommendation, which was made in the Board's annual report for each year since 1887, is renewed:

All persons operating bridges over navigable rivers were required by the act of August 7, 1882, to maintain such lights on them as may be required by the Light-House Board for the security of navigation. The Board in due time, and after careful examination and preparation, issued a set of regulations for lighting such bridges, fully illustrated by diagrams. Persons operating such bridges have, however, obeyed these regulations only so far as they have chosen. The Board, having been unable to induce full compliance with its rules, made a test case of the most important instance of failure to comply with its regulations, and reported the matter through the proper channels to the Department of Justice for legal action. The United States attorney to whom the matter was assigned reported in effect that he could accomplish nothing by prosecution, as "the statute prescribes no penalty for its violation and gives no remedy or means for its enforcement."

The United States attorney further states:

"That it is a common-law rule that when a statute forbids or requires an act to be done, an indictment will lie against an offender if the matter involved is one of public concern, but it is a familiar principle of Federal practice that crimes and their penalties must be the subject of specific Federal legislation, and recourse to common-law principles are therefore futile. It seems to me, therefore, * * * that, in order to remedy the evils to safe navigation in the East River by reason of improper lights upon the Brooklyn Bridge, * * * Congress must pass an act prescribing a punishment for disobedience to the orders of the Light-House Board."

It is therefore submitted that the proper steps should be taken to obtain the suggested legislation.

NECESSARY NEW STRUCTURES.

The following recommendation, made in the Board's annual report for each year since 1887, is renewed:

For several years past the Board has included in its annual estimates of appropriations, under the head of repairs and incidental expenses of light-houses, a clause stating that the objects of the appropriations are to be considered as "including necessary new structures." (*See* Book of Estimates, 1888–'89, p. 203). The object of this is to sanction a practice which has prevailed since the foundation of the Light-House Establishment until quite recently, viz, the erection at established stations, as the needs of the service may require, of additional structures of small cost from the current annual appropriations. The clause in question has, however, been cut out by the Committee on Appropriations of the House of Representatives from year to year, to the great embarrassment of the service, as under such circumstances the auditing officers are of the opinion that any improvements involving a new structure can not be made, no matter how much it may be needed, or how insignificant the cost may be. This tends to defeat one of the objects for which the appropriation is made, viz, to keep the service in efficient practical working order, and to adapt it to the changing necessities of commerce. It is, therefore, respectfully asked that steps may be taken to urge Congress to include in the appropriation bill for the coming year the clause in question.

CONTINUING APPROPRIATIONS.

The accounting officers of the Treasury hold that the provisions of the act of June 20, 1874, to the effect that appropriations for light-houses shall continue available until otherwise ordered by Congress, is to be construed literally as applying to "light-houses" only, and not to range lights, fog signals, light-vessels, and other works of construction and repair under the Light-House Establishment. On account of unavoidable delays in obtaining titles to sites, preparing plans, and making contracts, much of the construction and repair work provided for by the annual appropriation bills can not be completed within the fiscal year for which the appropriations are made. In order that the works provided for may be duly completed as contemplated by Congress, the Board recommends that a proviso be inserted in the next sundry civil appropriation bill similar to the enactment already made in regard to the appropriations for rivers and harbors, and fortifications, to the following effect, viz: "*Provided*, That the money herein and hereafter appropriated for all works of construction and repair under the Light-House Board shall be available until expended."

SUPPLIES OF LIGHT-HOUSES.

The appropriation of 1894 was $385,000; but while the appropriation was somewhat increased over that of the previous year, the number of light-stations was also increased, and it is reasonable to expect that appropriations will be made during the next session of Congress for still other light-stations.

The small amounts appropriated for supplies in several years past made it impossible for the Board to keep up its reserve stock of supplies with which to meet emergencies. This stock has been drawn upon to a large extent. The meagerness of preceding appropriations has made it necessary for the Board to scale down the quantity of supplies furnished yearly to the light-houses to such a point that it can go no further without danger that the lights may be extinguished. The severest economy has been practiced for several years and is being used this year, and as the number of lights has increased it is feared that the present lights and those which are being built can not be properly kept up from the current appropriation. The passage of the eight-hour law has enhanced the price of much manufactured material used to supply light-houses. The Board, therefore, estimates, as it did last year, that $410,000 will be needed during the coming fiscal year.

SALARIES OF LIGHT-HOUSE KEEPERS.

Last year Congress appropriated $680,000 to pay the salaries of not exceeding 1,250 keepers. But 1,171 keepers were employed. In quite a number of instances the Board found itself unable to provide keepers for needed beacon lights which it had funds to build, and hence these lights were not established.

The statement made in the Board's last two annual reports in reference to this subject is repeated.

It has become necessary, in view of the great pressure on this appropriation, to temporarily omit filling certain vacancies as they occurred, where there was more than one keeper at a station. This has necessarily resulted in inferior service on the part of the overworked keepers remaining at those stations. Two men can not do the work of three properly for any extended term.

The duties of light-keepers have been greatly increased by the addition of steam fog-signal apparatus, requiring, in many cases, the attention of steam engineers. It has been found that it is impossible to obtain the services of men for many of these positions, for the pay offered, who hold certificates that they have passed examinations as steam engineers. Hence the Board has been unable to get the best results from its steam fog signals. The steam is not raised as soon as it might be so as to get the fog signal to sounding as soon as it should. The machinery gets out of order sooner than it would if in the charge of a skilled engineer. It remains out of use until a machinist is sent from a distant town at large expense in wages and transportation to fix it, and the life of the machine is much shorter than it would be if in the charge of a certificated engineer. It is poor economy to stint the pay of engineers to such point that the services of only the poorest can be commanded, as it costs so much to remedy the mistakes they unavoidably make.

It has been found in practice that it is difficult to retain in the service men of sufficient experience and ability to operate and take the proper care of the delicate, complicated, and expensive illuminating apparatus placed in their charge. Hence it costs more than it formerly did, and more than it ought, to keep this apparatus in running order. The Board therefore suggests that it would be better, from an economical point of view, to raise the average salary of the light-keeper to the amount fixed by law rather than to maintain it at its present rate, and especially to decrease it still more.

The Board anxiously feels the difficulty with which it retains its trained and experienced light-keepers. The pay they receive is insufficient to induce them to remain in the service. During the four years between March 4, 1885, and March 4, 1889, 769 persons entered the service by original appointment. During the four years which elapsed between March 4, 1889, and March 4, 1893, 672 persons received original appointments into the Light-House Service. Each of these appointments was made to fill a vacancy made by cause. These causes were death, resignation, or removal. Each removal was made for specified written and recorded cause, and never for political reasons. The removals number, say, one in seven of all the vacancies. The vacancies caused by death are inconsiderable in number. The vacancies caused by resignation are, say, between five and six out of every seven.

There were, on an average, say, 1,160 light-keepers in the service during each of the past four years, about 158 of whom vacated their places each year, and of that number there were 115 who resigned mainly because they could, by so doing, better their condition. It is, however, estimated that $700,000 will be needed on the present basis for salaries of light-house keepers during the next fiscal year.

EXPENSES OF LIGHT-VESSELS.

Congress appropriated $250,000 to defray the expenses of light-vessels during this fiscal year. The appropriation has been expended and many needed repairs go over to next year. A light-vessel was established off Boston Bay, Massachusetts, in October, and the expenses of her maintenance should be considered in making the appropriation

for the coming year. Much general damage was done light-vessels on the Atlantic and Gulf coasts by heavy storms. The usual wear and tear on the older light-vessels was greater than usual, owing to their increased age. The Board estimates, therefore, that the expenses of light-vessels for the ensuing fiscal year will be $350,000, and it is recommended that an appropriation of that amount be made therefor.

EXPENSES OF BUOYAGE.

Congress at its last session appropriated $376,000 for the expenses of buoyage during the current fiscal year. There are now some 4,600 buoys of all kinds in position. The terrible storms of the last two years did great damage to the buoyage of the Atlantic and Gulf coasts. The buoys which were carried away or sunk at their moorings were replaced from the stock held in reserve, and that reserve stock has not been replaced for lack of funds. The Board therefore will need a larger appropriation than usual, not only to meet the immediate wants of commerce, but to bring up its stock of reserve buoys to its normal condition. Many requests for placing new buoys during the past year were declined, not because they were not needed but because there were not sufficient funds at the Board's disposal to increase and maintain a larger number of buoys than those already in position. It is therefore recommended that $450,000 be appropriated for expenses of buoyage during the coming fiscal year.

LIGHTING RIVERS.

The post lights maintained on rivers do so much good and at such small cost that it seems desirable to extend the system. The Board has recommended that Pearl River, Mississippi, be added to the rivers which may be thus lighted. The appropriation of $300,000 made at the last session of Congress for lighting rivers will be barely sufficient to maintain the lights now established. The Board has been unable to grant requests for more lights on the rivers named in the appropriation, for lack of funds. It is estimated that it will cost $350,000 to maintain the river lights properly during the coming year, and recommendation is made that this amount be appropriated therefor.

INSPECTING LIGHTS.

The recommendation made in the Board's last annual report on this subject is repeated:

The Light-House Board consists of nine persons. Each member is supposed to be an expert in some branch of pharology, and for that reason he is detailed to this duty. His value to the service increases as he comes in personal contact with the local light officers while in performance of their duty, and this can be accomplished only by actual journeys to the various districts. The theory is that light-house inspectors and engineers inspect the light-houses, light-ships, light-house and buoy depots, and their appurtenances, and that the members of the Light-House Board

inspect the work of the inspectors and engineers. In proportion as this theory is carried into effect uniformity and precision of action is insured. Proper inspection by members of the Board is, however, limited by the fact that their mileage, or traveling expenses, can be paid only from the $3,000 appropriation made yearly for inspecting lights. Small as this appropriation is, it is burdened by the provision that from it must be paid the rewards offered for information as to collisions and for the apprehension of those who have damaged light-house property. It is therefore recommended that this amount be increased to $5,000 for the coming year, or that the Board be authorized to pay its members' mileage or traveling expenses from the several general and special appropriations to which the travel may pertain.

TELEPHONIC COMMUNICATION BETWEEN LIGHT-SHIPS AND SHORE.

The following recommendations, which are condensed from what appeared on the subject in the Board's annual report of last year, are renewed.

The Committee on Interstate and Foreign Commerce of the House of Representatives on September 16, 1893, referred, through the proper channels, to the Light-House Board for suggestion as to the propriety of its passage, House bill No. 37, which appropriates $150,000 to provide and maintain communication by telephone, telegraph, or otherwise with light-ships, light-houses, and life-saving stations on the coast, to secure prompt information of vessels in distress, and authorizing experiments to determine the most effective means for so doing. The Board replied, making urgent recommendation that the bill be enacted.

It is proposed by the Light-House Board, if funds are provided for the purpose, to first make electric connection between a light-house on a telegraphic shore line and an important light-ship, which, while it is near the shore, is at a point where it is passed by many vessels. These conditions would be met by connecting Sandy Hook beacon, New Jersey, with the Scotland light-ship, which are some 4 miles apart. Having done this, the Board proposes next to connect two such stations much farther apart, where the conditions of the bottom, current, and approaches are different. This could be done by laying a cable between Winter-Quarter Shoal light-ship and Assateague light-house, Virginia, some 11 miles distant. Then a cable might be run, say from Frying-Pan Shoals light-ship, some 18 miles, to Cape Fear light-house, North Carolina. This might be followed by a cable run from Five-Fathom Bank light-ship to Cape Henlopen light-house, Delaware, some 23 miles off. And this could be followed by laying a cable from Sankaty Head light-house, on the island of Nantucket, Massachusetts, to Nantucket New South Shoals light-ship, some 30 miles south and straight out into the Atlantic Ocean. This light-ship is the most distant from our coast of any in the service. It is in the track of all coasting vessels going outside of Nantucket from the north to the south and back, and of vessels going to and from Europe. It is an exceedingly important post and would be of immense value to commerce if communication could be had between that light-ship and the commercial centers.

The Light-House Board for several years has promoted experiments for obtaining electric communications between light-ships and shore. It has watched, with great care, the experiments made by other maritime countries, and it has noted the difficulties with which they have contended. The experiments recently made at the Board's instance have developed methods by which electric difficulties met by other light-house establishments may be overcome. The Board believes that it can now make and maintain electric communication between its light-ships and the shore stations, but the Board prefers to utilize the experience thus gained in going from the nearer to the farther by degrees, until the most distant and important light-ship is reached and the most difficult and expensive work is done.

As the Board has not been supplied with funds for making practical experiments, all that it has been able to do in this line is to promote the making of experiments in the laboratory, at the dock, and, in one instance, in connection with a relief light-ship anchored a short distance from the light-house depot where she belonged. Even this strained its resources, and they had to be supplemented by private means. Still, the results attained were such that the Board is now prepared to test, in actual practice, the plans formed after successful laboratory and dock experiments.

The views of the Board were asked on December 7, 1892, as to the passage of Senate bill No. 3512, appropriating $50,000 for, in effect, making experiments for this purpose. Favorable reply was made, and, in consequence, the amount named in that bill, $50,000, appears in the Board's annual estimates.

The amount, $150,000, named in the House bill No. 37, is none too much to purchase the material and plant and to pay for the labor and scientific supervision needed to do the work proposed; but as it will be a work of years if the work is done ship by ship, instead of all at once, all the Board asks is $50,000, the amount which can properly be expended in the work during the coming fiscal year.

GAS BUOYS.

The following statement, which was made in the Board's annual report for the last two years, is renewed:

The buoy used is of the Pintsch pattern and patent. It is forged by a secret process without seam and holds compressed gas without perceptible loss, which burns with a steady flame and which is rarely extinguished from any cause, making a useful light. The gas buoy is sometimes used to replace, temporarily, a light-ship while the latter is under repair. It is sometimes used where a light-ship can not be moored. A dangerous wreck in an important channel leading into New York had to be marked, and as the channel was too narrow to admit of a light-ship being placed near the wreck a Pintsch gas buoy was used there satisfactorily, to the great advantage of shipping, for a considerable length of time and until the wreck had disappeared. The Board in 1891 placed a lighted gas buoy in the fairway of vessels going north and south near to the wrecks of the steamer *Vizcaya* and the schooner *Hargraves*, off Barnegat light, on the New Jersey seacoast, where it served to keep vessels from running on

to these wrecks. In the summer of 1892 it placed a gas buoy in Pollock Rip Slue, Massachusetts, off the wreck of the yacht *Alva*, which was also in the fairway of vessels going north and south. A gas buoy was also placed so as to mark a wreck in Boston Harbor, and the buoy was kept there until the wreck was broken up and disappeared.

On August 18, 1894, a gas buoy was again placed in Pollock Rip Slue to mark the wreck of a coal barge. When the wreck was removed by the United States engineers the gas buoy was removed, only to place it so as to guide vessels clear of the wreck of the schooner *Mary J. Castner*, sunk between Pollock Rip and Chatham, Mass.

A gas buoy was established off Gardiners Island, Long Island Sound, after the discontinuance of Gardiners Island light-station, and it answers the purpose of a light-house.

Several gas buoys were established to mark channels, each of which, if not as satisfactory as a light-house, serves the purpose. The Board has had to decline to grant applications for the establishment of gas buoys at many places where they are needed, for lack of buoys. No appropriation was made last year for gas buoys. The Board now recommends that $50,000 be appropriated for the purchase of gas buoys during the coming fiscal year.

NEW LIGHT-SHIPS.

The Board has recommended in the proper places in the body of this report that appropriations be made for building four new light-vessels. Each is much needed, but attention is especially invited to the urgent necessity for a relief light-vessel in the Fourth light-house district, and for a light-vessel on the Pacific coast near Umatilla Reef, off the Strait of Juan de Fuca, Washington.

NEW TENDERS.

Recommendation is made in certain of the following pages that appropriations be made for the construction of three steamers to be used as light-house tenders in the Second, Third, and Seventh light-house districts, to replace old steamers now so nearly worn out that they can only last, if used with care, until new vessels can be built to take their places. The Board has also recommended that the steam launch *Bouquet*, which was used to attend the Gedney Channel electric buoys, and which was wrecked by the cyclone of October 21, 1893, be replaced, at an expense of $4,000, by a new steam launch to be built for the purpose.

APPENDICES TO THIS ANNUAL REPORT.

Electric lights, Gedney Channel buoys.—The account given in Appendix No. I of the operation of the electric lights on the buoys which mark the Gedney Channel from the ocean into New York Bay is from the pen of Lieut. Commander C. H. West, U. S. Navy, assistant to the

inspector of the Third light-house district, who has had them under his personal charge. These lighted buoys, which are almost unique in the history of pharology, are highly valued, especially by each of the deep and fast steamers which make New York a terminus of its route. This report shows something of how these floating electric lights have reached their present high standard.

The foundation of Wolf Trap light-station.—An account of this interesting work is given in Appendix No. II, by Capt. Eric Bergland, Corps of Engineers, U. S. Army, engineer of the Fifth light-house district, under whose direction the work was planned and accomplished.

Light-house exhibit at the Columbian Exposition.—The Board's exhibit at Chicago in 1893, an account of which is given in Appendix No. III, by Mr. A. B. Johnson, chief clerk of the Light-House Board, was not what it might have been, or what the Board wished to make it; but it was the best that could be done with the funds furnished and the space allowed.

Pierhead conduits.—An ingenious, inexpensive, and successful arrangement has been put into operation among the pierhead lights on the upper Great Lakes, by means of which a light is hauled out at night to the pierhead, and is hauled in at sunrise. This saves the building of expensive and cumbersome elevated walks, which being carried away by heavy storms have to be replaced at large expense of time, trouble, and money. The description of this device, which is submitted as Appendix No. IV, is from the pen of Maj. M. B. Adams, Corps of Engineers, U. S. Army, engineer of the Ninth and Eleventh light-house districts, who devised the plan, and under whose direction it has been carried into successful operation.

Fog signals.—An account of the experiments with fog signals is submitted as Appendix No. V to this report. It is from the pen of Maj. W. R. Livermore, Corps of Engineers, U. S. Army, who has served as engineer of the First and Second light-house districts for several years. This report is so valuable not only to the Light-House Establishment of the United States, but those of all other countries, that the Board feels an especial pride in its presentation. It presents in consolidated form all accessible data as to previous observations and experiments heretofore made in other countries as well as in this, including his own, which are perhaps more extended than those ever made by any other person. The subject has been treated with a fullness of knowledge and ripeness of judgment which has heretofore been possible to no other writer.

THE FLAG AT LIGHT-STATIONS.

The Board in session on October 1, 1894, decided that it would take measures, as soon as practicable, to display the United States flag from each light-house. A committee was directed to formulate a plan and estimates for carrying the decision into effect. The committee

recommended that two flags, one 10 feet and the other 6 feet long, and that a white 80-foot flagstaff consisting of lower mast, with serving halyards, be furnished to each light-station on land, and that on rock lights the topmast be rigged on their towers. This it is estimated will cost about $130 per station, or for the 930 stations which should display flags about $121,000.

It thought that some 300 light-stations can be supplied with flags and flagstaffs during the coming fiscal year. The Board therefore recommends that an appropriation of $40,300 be made for displaying the United States flag at light-stations.

PERSONNEL.

The following changes have taken place in the personnel of the Light-House Board since the date of the last annual report:

On February 28, 1894, Capt. Frederick A. Mahan, Corps of Engineers, U. S. Army, engineer secretary, was relieved by Capt. Philip M. Price, Corps of Engineers, U. S. Army.

NOTE.—On October 4, 1894, Capt. Price, while on a tour of inspection duty, died suddenly of œdema of the lungs. He was succeeded on November 7, 1894, by Capt. John Millis, Corps of Engineers, U. S. Army.

When the death of Capt. Price was formally announced to the Board at its session on November 5, 1894, the following action was taken:

Resolved, That in the death of Capt. Philip M. Price, Corps of Engineers, U. S. Army, the Light-House Board has lost an industrious, and faithful member.

Resolved, That the Board has lost in his death a secretary who showed high ability as an executive officer.

Resolved, That we, his brother members of the Board, deplore his death, as thus we each have lost a personal friend, who, by his kindness of heart, and genial bearing, has commanded our respect and won our affection.

Resolved, That we tender to the widow of the deceased our sympathy in her great bereavement.

Resolved, That these resolutions be spread on the journal of the Board, and that a properly engrossed and certified copy of them be sent to the widow of the deceased.

ESTIMATES FOR GENERAL APPROPRIATIONS.

Supplies of light-houses	$410,000.00
Repairs of light-houses	750,000.00
Salaries of keepers of light-houses	700,000.00
Expenses of light-vessels	350,000.00
Expenses of buoyage	450,000.00
Expenses of fog signals	125,000.00
Inspecting lights	5,000.00
Lighting of rivers	350,000.00
Survey of light-house sites	1,000.00

ESTIMATES FOR SPECIAL APPROPRIATIONS.

Alligator River light and fog signal, North Carolina	20,000.00
Ames Ledge light-station, Kennebec River, Maine	75.00
Amite River light-station, Louisiana, fog signal	1,200.00

Apalachicola Bay range lights, Florida	$7,000.00
Bayfield light-station, Lake Superior, Wisconsin	5,000.00
Bay State Shoal lights, New York	800.00
Beaufort Harbor range lights, North Carolina	10,000.00
Big Oyster Beds light and fog-signal station, New Jersey	25,000.00
Big Sable fog signal, Lake Superior, Michigan	5,500.00
Biscayne Bay light-station, Florida	1,000.00
Black Ledge light and fog-signal station, Connecticut	45,000.00
Black River or Lorain steam fog signal, Lake Erie, Ohio	4,300.00
Blockade Shoal, off Pork Point, light and fog-signal station, North Carolina	20,000.00
Bodega Head light and fog-signal station, California	30,000.00
Boon Island light-station, Maine, keeper's dwelling	3,4 0.00
Boston Harbor light-ship, Massachusetts	35,000.00
Buckle Island range lights, Maine	14,000.00
Burnt Coat Harbor light-station, Maine, roadway	500.00
Butler Flat light and fog-signal station, Massachusetts	45,000.00
Cape Elizabeth light-station, Maine, keeper's dwelling	3,300.00
Cape Fear light-station, North Carolina	70,000.00
Cape Fear River range lights, North Carolina	3,105.00
Cape Flattery fog-signal station, Washington, new site	17,000.00
Cape Lookout Shoals light-ship, North Carolina	70,000.00
Cape Mendocino light-station, California, roadway	500.00
Carlton Island light-station, Lake Ontario, New York	8,600.00
Cheboygan River front range light-station, Straits of Mackinac, Michigan, additional land	1,750.00
Chequamegon Point light and fog signal station, Lake Superior, Wisconsin, moving and rebuilding La Pointe main light and establishing harbor bell and light	10,000.00
Christiana light-station, Delaware, raising light to fourth order and establishing post light	9,100.00
Clark Ledge light and fog-signal station, Maine	30,000.00
Cleveland light-station, Ohio (new site), keeper's dwelling and storehouse	25,000.00
Conneaut range light-station, Ohio, beacon light	2,500.00
Deadman Island light and fog signal, San Pedro Harbor, California	5,000.00
Deer Point light-station, Pensacola Bay, Florida	1,000.00
Depot for Sixth light-house district, at or near Charleston, S. C	155,000.00
Depot for Ninth and Eleventh light-house districts, Scammons Harbor, Lake Huron, Michigan	15,000.00
Detroit light-house depot, Michigan, paving Mount Elliot avenue	2,000.00
Devils Island, Apostle Group, Lake Superior, Wisconsin, permanent tower	22,000.00
Doller Point range lights, James River, Virginia	2,500.00
Doubling Point light and fog-signal station, Kennebec River, Maine	6,300.00
Eagle Harbor fog signal, Lake Superior, Michigan	5,500.00
Eagle River light-station, Lake Superior, Michigan, moving light to Sand Hills	20,000.00
Edgemoor light-house and buoy depot, Delaware, repairing	30,800.00
Egmont Key light-house and buoy depot, Florida	10,000.00
Egmont Key light-station, Florida, change to third order	6,000.00
Egmont Key light-station, Florida, keeper's dwelling	4,000.00
Electric communication with light-vessels	50,000.00
Erie light-house and buoy depot, Pa	35,000.00
Escanaba fog signal, Lake Michigan, Michigan	1,100.00

Fairport fog signal, Lake Erie, Ohio	$4,700.00
Florida Reefs beacons, Florida, restoring	10,000.00
Fort Niagara light-station, New York, keeper's dwelling	4,000.00
Fort Wadsworth light and fog-signal station, New York, moving from Fort Tompkins	1,500.00
Galloo Island fog signal, Lake Ontario, New York	5,700.00
Galveston South Jetty light-station, Texas, light and fog signal	35,000.00
Gas buoys	50,000.00
Gladstone light-station, Lake Michigan, Michigan	10,000.00
Grand Marais light-station, Minnesota, to apply unexpended balance of appropriation to purchase of site for and construction of dwelling, $8,409.17	(*)
Grand Marais light and fog signal, Lake Superior, Michigan	15,000.00
Grassy Island North Channel range light-station, Michigan	5,500.00
Dwelling for keeper at this station	4,500.00
Grassy Island South Channel range light-station, Michigan	700.00
Grays Harbor light and fog-signal station, Washington, completing	39,500.00
Green Island light-station, Maine	12,000.00
Grosse Isle North Channel range light-station, Michigan, keeper's dwelling	3,500.00
Grosse Isle South Channel range light-station, Michigan, keeper's dwelling	5,000.00
Grossepoint range light-station, Michigan	8,260.00
Halibut Rock day beacon, Maine	300.00
Hat (or Pats) Point light and fog signal, Lake Superior, Minnesota	15,000.00
Heron Neck light-station, Maine, keeper's dwelling	3,300.00
Hillsboro Inlet light-station, Florida	90,000.00
Inside Passage beacon lights, Georgia and Florida	4,000.00
Kewaunee Pierhead light-station, Wisconsin, site and double keepers' dwelling	7,000.00
Key West light-house and buoy depot, Florida	10,000.00
Lazaretto Point light-house depot, Maryland, keeper's dwelling	2,500.00
Libby Islands light-station, Maine, keeper's dwelling	6,200.00
Little Gull Island light and fog-signal station, Michigan	20,000.00
Little River Head fog-signal station, Maine	10,500.00
Lower Cedar Point light-station, Potomac River, Maryland	75,000.00
Ludington Pierhead light and fog-signal station, Lake Michigan, Michigan, keeper's dwelling	4,500.00
Mahon River range light-station, Delaware, new site	8,500.00
Manistique light and fog-signal station, Michigan	32,000.00
Manitowoc light-station, Wisconsin, fog signal	5,500.00
Marblehead light-station, Massachusetts, new tower	45,000.00
Mary Island, Alaska, beacon light	800.00
Matinicus Rock light-station, Maine, keeper's dwelling	3,200.00
Maumee Bay range light-station, Ohio, beacons and keeper's dwelling	25,000.00
Maurice River range light-station, New Jersey	4,500.00
Menasha range lights, Wisconsin	500.00
Mendota light-station, reestablishment, Lake Superior, Michigan	10,000.00
Mermenteau River light-station, Louisiana	7,000.00
Michigan City light-station, Indiana, fog signal	5,500.00
Mobile ship channel lights, Alabama	30,000.00
Mount Cornelia light-station, Florida	125,000.00
New Canal light-station, Louisiana, fog signal	1,200.00
New York Slough light and fog-signal station, California	10,000.00

*Authority.

North Head, Cape Disappointment, light-station, Washington	$25,000.00
North Manitou light and fog-signal station, Michigan	20,000.00
Oil houses for light-stations	15,000.00
Old Mackinac Point light-station, Michigan, additional land	1,000.00
Overfalls Shoal light-vessel, New Jersey	70,000.00
Oyster Bayou light-station, Louisiana	5,000.00
Pass Manchac light-station, Louisiana, fog signal	1,200.00
Pensacola light-house and buoy depot, Florida	15,000.00
Perkins Island light-station, Kennebec River, Maine	5,700.00
Peshtigo Shoal light and fog-signal station, Wisconsin	10,000.00
Pigeon Point light-station, California, enlarging site	5,000.00
Plum Beach light and fog-signal station, Rhode Island	60,000.00
Poe Reef light-ship, Straits of Mackinac, Michigan	25,000.00
Point Arguello light and fog-signal station, California	35,000.00
Point Buchon light and fog-signal station, California	33,000.00
Point Hueneme light-station, California, additional land	3,000.00
Point No Point light-station, Chesapeake Bay, Maryland	70,000.00
Point No Point light-station, Washington, fog signal	6,000.00
Point Pinos light-station, California, additional land	2,000.00
Portage Lake and River lights, Michigan	10,500.00
Portage Lake Ship Canal Pierhead fog signal, Lake Superior, Michigan	5,500.00
Portage Lake light-station, Michigan	3,500.00
Port Clinton light-station, Lake Erie, Ohio, reestablishing	1,500.00
Porte des Morts range lights and fog-signal station, Lake Michigan, Michigan	21,000.00
Portsmouth light-house depot, Virginia, repairing wharf, etc	40,000.00
Presqu'ile Pierhead fog signal, Erie Harbor, Lake Erie, Pennsylvania	4,300.00
Puget Sound channel lights, Washington	4,200.00
Punta Gorda light and fog-signal station, California	40,000.00
Quarry Point fog-signal station, San Francisco Bay, California	6,000.00
Ram Island day beacon, Maine	300.00
Rappahannock River, Virginia, additional lights	3,300.00
Reimbursement of losses of seamen in the Light-House Service	127.25
Reimbursement of losses of light-keepers in the Sixth light-house district	2,399.13
Reimbursement for losses of light-keepers in the Eighth light-house district	2,603.62
Relief light-vessel for the Fourth light-house district	70,000.00
Sabine Pass Jetty light-station, Louisiana	500.00
St. Joseph Point light-station, Florida	25,000.00
St. Joseph Pierhead fog signal, Lake Michigan, Michigan	5,000.00
St. Martin Island light and fog-signal station, Green Bay, Michigan	15,000.00
Santa Barbara light-station, California, keeper's dwelling with tower attached	7,500.00
Sheboygan Pierhead fog signal, Wisconsin	5,500.00
South Fox Island fog signal, Michigan	5,500.00
Southwest Ledge light-station, Connecticut, fog signal	3,000.00
South Milwaukee light-station, Wisconsin	7,500.00
Southwest Pass light-station, Louisiana, keeper's dwelling	10,000.00
Spectacle Island range lights, Boston Harbor, Massachusetts	9,350.00
Spring Point Ledge light and fog-signal station, Maine	45,000.00
Squirrel Point light-station, Kennebec River, Maine	4,650.00
Staten Island light-house depot, New York, seawall, etc	100,000.00
State Ledge light and fog-signal station, Massachusetts	42,000.00
Steam launch for the Third light-house district	4,000.00
Sturgeon Bay Canal light-station, Lake Michigan, Wisconsin	20,000.00

Superior and St. Louis Bay lights, Minnesota	$11,200.00
Swan Point Bar light and fog-signal station, Maryland	70,000.00
Tail Point light-station, Wisconsin, constructing crib and moving light and bell	7,500.00
Tender for the Second light-house district	85,000.00
Tender for the Third light-house district	95,000.00
Tender for the Seventh light-house district	80,000.00
Tibbetts Point fog signal, Lake Ontario, New York	4,300.00
Tobago day beacon, Virginia	3,000.00
Warwick fog-signal station, Rhode Island	5,000.00
Whitlocks Mill light-station, Maine	250.00
White Rocks light and fog-signal station, Maryland	10,000.00
Willamette River post lights, Oregon	5,000.00
Wilson Harbor light-station, Lake Ontario, New York	2,500.00
Wreck Point light-station, North Carolina	5,000.00
Umatilla Reef light-ship, Strait of Juan de Fuca, Washington	80,000.00
Yerba Buena light-house and buoy depot, California, reestablishing wharf.	30,000.00
Pumping plant for increasing water supply	5,100.00

FIRST DISTRICT.

The First district extends from the head of navigation in the St. Croix River, Maine, the eastern boundary of the United States, to and including Hampton Harbor, New Hampshire, and includes all the aids to navigation on the coasts and in the navigable bays, rivers, and inlets of Maine and New Hampshire.

Inspector.—Commander George E. Wingate, U. S. Navy.

Engineer.—Maj. William R. Livermore, Corps of Engineers, U. S. Army.

In this district there are—

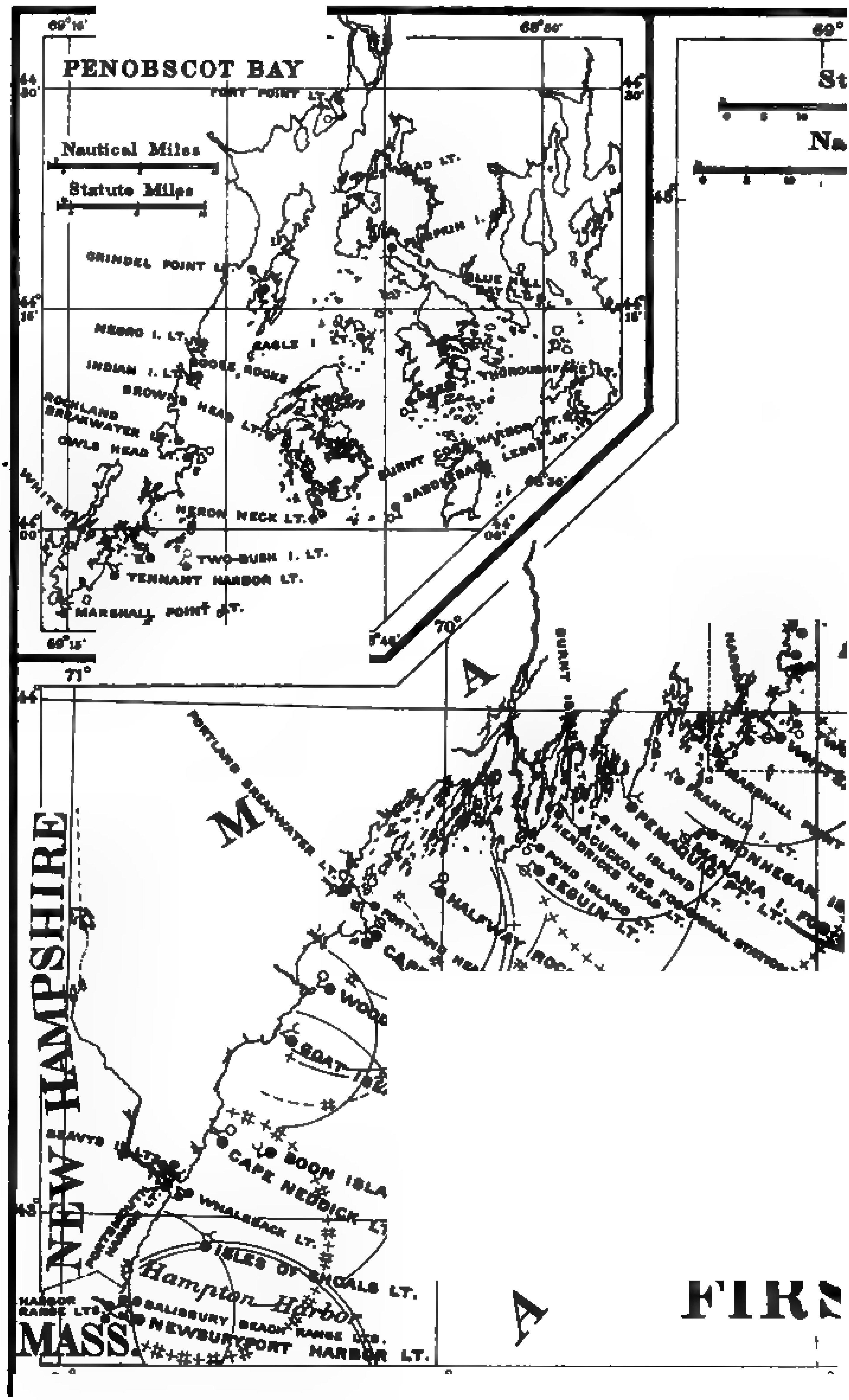
Light-houses and beacon lights	66
Day or unlighted beacons	104
Fog signals operated by steam or hot-air engines	13
Fog signals operated by clockwork	17
Whistling buoys in position	10
Bell buoys in position	16
Other buoys in position	640
Steamer *Lilac*, buoy tender, and for supply and inspection	1
Steamer *Myrtle* for construction and repair in the First and Second districts	1

The number preceding the name of a light-station is that by which it is designated in the list of lights and fog signals on the Atlantic and Gulf coasts of the United States, corrected to January 1, 1894, or in the list of lights and fog signals on the Pacific coast of the United States, corrected to January 1, 1894, or in the list of lights and fog signals of the United States on the Northern lakes and rivers, corrected to the opening of navigation, 1894.

1. Whitlocks Mill, on the south bank of the St. Croix River, Maine.—A light was needed at this place to enable the steamers, plying between Eastport and Calais, and especially towboats, to make the difficult turn at the Narrows, a few hundred yards above Whitlocks Mill. The Canadian Government maintains two lights on the left or Canadian bank of the river, and another light was needed on the right or American bank to make the navigation safe at this difficult turn. Hence a red light was, on July 15, 1892, shown from a tree as a temporary expedient. It is now proposed to purchase a site for this light. The owner of the land offers it at a reasonable price. It is estimated that its purchase, together with the legal expenses necessary to obtaining title and cession of jurisdiction, will cost not to exceed $250. Recommendation is made that an appropriation of that amount be made for this purpose.

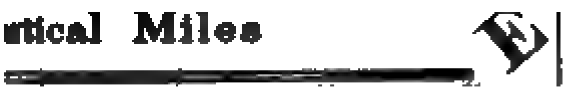
—. *Clark Ledge, St. Croix River, near Eastport, Maine.*—The following recommendation, made in the Board's last five annual reports, is renewed:

Vessels navigating the St. Croix River need a light to guide them to its entrance between the whirlpools off Deer Point and Dog Island, near Eastport. Clark Ledge



PENOBSCOT BAY
Nautical Miles
Statute Miles
FORT POINT LT.
GRINDEL POINT LT.
NEGRO I. LT.
EAGLE I. LT.
INDIAN I. LT.
GOOSE ROCKS
BROWNS HEAD LT.
ROCKLAND BREAKWATER LT.
OWLS HEAD LT.
BLUE HILL BAY LT.
HERON NECK LT.
TWO-BUSH I. LT.
TENNANT HARBOR LT.
MARSHALL POINT LT.
NEW HAMPSHIRE
MASS.
PORTLAND BREAKWATER LT.
HALFWAY ROCK
SEGUIN LT.
POND ISLAND LT.
HENDRICKS HEAD LT.
CUCKOLDS FOG SIGNAL STATION
RAM ISLAND LT.
PEMAQUID PT. LT.
MANANA I.
MONHEGAN IS.
FRANKLIN I. LT.
MARSHALL POINT
BOON ISLA
CAPE NEDDICK
WHALEBACK LT.
ISLES OF SHOALS LT.
Hampton Harbor
SALISBURY BEACH RANGE LTS.
NEWBURYPORT HARBOR LT.
HARBOR RANGE LTS.
FIRS

tical Miles



near the shore in Eastport Harbor, almost covered at high water, is very dangerous to navigation, and has caused the loss of several vessels. A light here would serve the twofold purpose of guiding vessels to the entrance of the river and clear of this dangerous ledge. For this purpose an appropriation of $30,000 is needed. The legislature of Maine has conveyed title to the ledge and jurisdiction over it to the United States, so that the light-house may be erected whenever an appropriation therefor is made by Congress.

It is recommended that an appropriation of $30,000 be made therefor.

5. *Little River Head, mouth of Little River, Cutler Harbor, Maine.*—The following recommendation, which was made in the Board's last five annual reports, is renewed:

Cutler Harbor is a station of the Eastport, St. John, and Bay of Fundy pilots. It is rapidly growing as a summer resort. Vessels making the Bay of Fundy first make Libby Islands, and then try to make Little River light. Steamers of the International Line wish to make this a harbor and stopping place. They carry much freight and many passengers. It is the only near harbor of refuge, and is used as such by vessels when they can get in; but this is impossible in a fog, without the aid of a fog signal. The Spanish steamer *Eduardo* struck at low tide on July 21, 1889, on Old Man Island, 2 miles south of Cutler Harbor, at midnight and during a dense fog. She filled with water and proved a total loss. The crew, numbering 40 men in all, were saved. She registered 2,308 tons and cost $285,000. The inspector of the First light-house district made a report relating to this wreck, from which the following extracts are taken:

"The steamer *Eduardo* arrived near Libby Islands light and fog-signal station on the morning of July 20, and remained in that vicinity until near midnight, occasionally standing out seaward and then returning, apparently keeping between the two signals of Libby Islands and Seal Island.

"The weather was calm, with a rough sea and dense fog. About 9 p. m. it scaled up so that Libby Islands and Moose Peak lights were visible, and soon after the vessel was headed east by north at slow speed, with frequent casts of the lead.

"At about midnight, fog being very thick, the vessel struck on Old Man, having heard neither the automatic fog bell of Little River light-station, 2¾ miles distant to the eastward, nor the whistling buoy off same place, 3¼ miles distant, bearing about E. ¼ N."

From an inspection of the chart it will be seen that Little River and Harbor opens to the southeast and that the high land of Little River Head covers the light-station until it is brought to bear about north. A steam fog signal at th[illegible]t-station might or might not be heard near the Old Man; it would not be h[illegible] certainly at it full strength; but located on Little River Head it would be exposed in all directions seaward and would in this case, without any doubt, have been the greatest possible assistance in guiding the *Eduardo* to that point; the whistling buoy could then have been picked up and a fresh departure taken, or the vessel could have entered the harbor of Cutler.

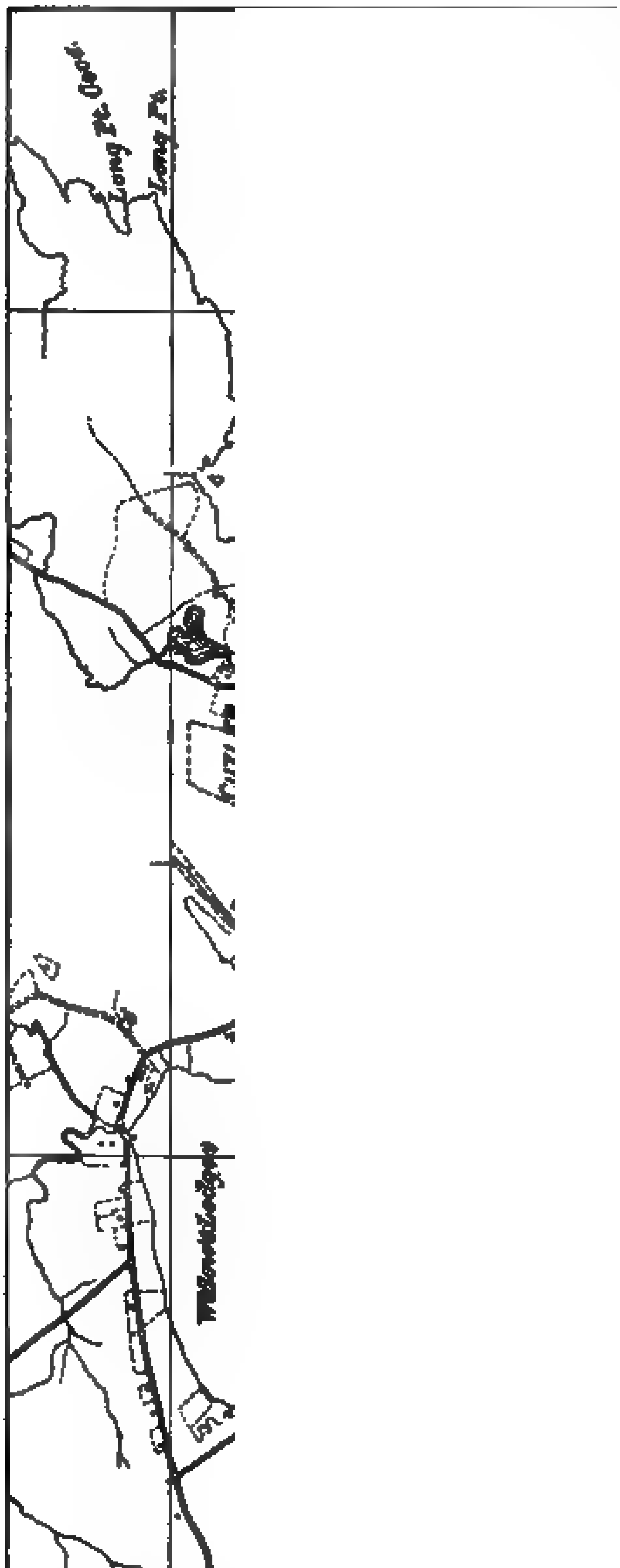
The following is an extract from the report of her master of the wreck of the *Eduardo*:

"If at the western point of Little River there had been a fog whistle or trumpet, I assure you this accident would not have occurred; so that, in my opinion, it is absolutely necessary there should be at that point some fog signal operated by steam during foggy weather."

The Board is also of opinion that this wreck would not have occurred had the fog signal now recommended for Little River Head then been in operation. It is estimated that the establishment of such a signal would cost $10,500, and the appropriation of that amount is therefore recommended.

First District.

7. *Libby Islands, on southwest end of the southwesterly of the Libby Islands, entrance to Machias Bay, Maine.*—A boiler taken from Cape Elizabeth station was repaired and installed. The characteristic of the



fog signal was changed from a blast of 4 seconds, interval 4 seconds, blast 4 seconds, interval 18 seconds; to blasts of 2 seconds' duration separated by silent intervals of 13 seconds. Minor repairs were made to the fog-signal machinery and boilers. A brick oil house was built.

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Since the recommendation of the last two years for an appropriation for a single dwelling for an assistant keeper, it has become necessary to provide quarters for another assistant, making two sets of quarters urgently needed, as there is now but one set for three keepers. It is therefore recommended that a double dwelling be built, at an estimated cost of $6,200, instead of the single dwelling heretofore recommended.

11. Narraguagus, on east side of Pond Island, at the entrance to Narraguagus Bay, Maine.—The walls of the light-house were reinforced by additional brick masonry, and a new iron lantern deck was provided and put in place. The interior lining of the tower was partly rebuilt, and the tower was provided with new iron stairs. The boathouse was repaired; minor repairs were made to the dwelling, and a boundary fence was built.

21. Bass Harbor Head, east side of entrance to Bass Harbor, Maine.—A boathouse 12 by 24 feet in plan and a boat slip 100 feet in length were built.

22. Burnt Coat Harbor, Swan Island, coast of Maine.—This station is situated at the extreme end of the peninsula and is separated from the town by the harbor. In winter the harbor is sometimes filled with ice so that communication with the town by water can not be relied upon; a roadway for the accommodation of the necessary travel between the public road and the light-station is therefore necessary. The owners of the adjacent land offer to convey right of way to the Government at a nominal price. It is estimated that the legal expenses of obtaining title and cession of jurisdiction to the land thus conveyed, together with the cost of building the road needed, will not exceed $500. Recommendation is made that an appropriation of this amount be made therefor.

—. *Green Island, entrance to Burnt Coat Harbor, Maine.*—Burnt Coat Harbor is an excellent and capacious harbor. The range lights which guided vessels to the entrance were unsatisfactory. One of them, therefore, was discontinued. The following recommendation, made in the Board's estimates and reports for the last nine years, is repeated:

> It is proposed to erect a light-house on Green Island, about a mile to the southward of the entrance. It is recommended that an appropriation of $12,000 be made therefor.

—. *Buckle Island, entrance to York Narrows, Maine.*—The Board is informed that something more than 1,000 sailing vessels, carrying lumber, fish, hay, coal, granite, and general merchandise, annually use this passage. There are also several lines of steamboats, some of which make two trips a day, carrying large numbers of passengers to and from Bar Harbor and other points along the shore, which would be benefited by lights on Buckle Island. In the early spring and late fall steamers, and especially sailing vessels, find it necessary to go

First District.

through the passage during the night, when a light on Buckle Island would be of great assistance to them. It is further stated that several vessels have been cast away on Buckle Island, among them the schooner *Walter Scott*, which was wrecked in the winter of 1870. It is proposed, if the necessary appropriation is made, to place a white light with four red sectors, with a post range light 100 feet in front of the main light. It is estimated that these range lights can be established at a cost not exceeding $14,000, and it is recommended that an appropriation of this amount be made therefor.

—. *Halibut Rock day beacon, Jericho Bay, East Penobscot Bay, Maine.*—A tripod is needed on the west part of Halibut Ledge. This is especially important as the United States mail and passenger steamboat arrives at Old Harbor after dark, as well as to accommodate the large number of vessels that daily take shelter in Burnt Coat Harbor. It is estimated that the building of the beacon, the purchase of the site, and obtaining the cession of jurisdiction will cost $300. The Board therefore recommends that an appropriation of that amount be made for this purpose.

29. *Heron Neck, on Green Island, East Penobscot Bay, Maine.*—The following recommendation, made in the Board's last three annual reports, is renewed:

The keeper's dwelling, built when the station was established in 1853, was designed to be an excellent one, having 8-inch brick walls separated by a 2-inch air space from a 4-inch brick lining and having interior 4-inch brick partitions. It is, however, understood to have been built by contract, and so little mortar was used that many of the joints do not appear to have been filled. In driving rainstorms they receive large quantities of water, which keep the walls very damp and almost incessantly exude moisture into the dwelling. The dampness of the dwelling is further increased by the character of the site, which is underlaid by a sloping ledge, over which the water flows, saturating the soil surrounding the dwelling and keeping its cellar wet. From these causes the dwelling is unhealthy and is unsuitable for occupancy in so severe a climate. It is claimed that on this account five deaths have occurred in it since its erection in 1853. It would cost to remedy these radical defects in the walls and of the site almost, if not quite, as much as it would to erect a new building on a proper site. A new building on a better site, it is estimated, would cost $3,300, and it is recommended that an appropriation of this amount be made for that purpose.

30, 31. *Matinicus Rock, on Matinicus Rock, off the southern entrance to Penobscot Bay, Maine.*—The stone house was renovated, repaired, and made habitable for the third assistant keeper. The workroom of north tower was replastered, and minor repairs were made to all the quarters. A railway for hauling coal from the boathouse to the fog-signal house was built and a car was provided. A donkey engine and boiler were installed in a small house near the boathouse for hauling boats out on the ways and hauling coal from the boathouse to the signal house. A brick reservoir with roof, to hold 15,000 gallons, was built for storing fresh water; a platform of 500 feet area was built on the

north side of the boat slip to facilitate the landing of materials and supplies. Minor repairs were made to the fog-signal machiney, boilers, dwellings, and workroom. The following recommendation, which was made in the Board's last three annual reports, is renewed:

For more than twenty years, and until recently, the first assistant keeper was the son of the principal keeper, and the two lived together in one dwelling. The resignation of the principal keeper has broken up this arrangement. At this important station, which has two second-order lights and a steam fog signal, a keeper and three assistant keepers are employed. These are the only people living on this rock. Two of the assistant keepers, with their familes, live in one double dwelling, and the principal keeper lives in a separate single dwelling. These three sets of quarters are adapted only to the accommodation of three families, and a fourth set of quarters is, therefore, urgently necessary for the third assistant. It is estimated that a proper dwelling can be built for $3,200, and recommendation is made that this amount be appropriated for that purpose.

This bare, rocky islet is about half a mile long and of irregular width, nowhere exceeding an eighth of a mile, and the highest part is not more than 50 feet above the sea level. There is a little cove where material can be hauled up in pleasant weather, but it has no harbor. The light-house keeper effects a landing by steering his boat through the breakers on the top of a wave, so that it will land on the boat-ways, where his assistants stand ready to receive him and draw his boat so far up on the ways that a receding wave can not carry it back to the sea. There is neither tree nor shrub, and hardly a blade of grass on the rock. The surface is rough and irregular, and resembles in a large way a confused pile of loose stone. Portions of the rock are frequently swept by the waves, which move the huge bowlders into new positions. During the storm of January 19, 1856, the sea made a complete breach over the rock, washing away every movable thing. The old dwelling was so thoroughly demolished that not one stone was left upon another. The then new dwelling, though situated in the most protected spot, was flooded, and heavy wooden shutters had to be closed to prevent the violence of the spray from breaking them in. The rock is about 20 miles from the mainland, as the crow flies. Rockland, 25 miles distant, is the nearest harbor unless the coves of Matinicus Island, 4 miles from the rock, be considered as harbors. They can be entered only with certain winds by vessels of very light draft. The isolation of this station and the difficulty of landing material here of course enhance the cost of erecting the proposed structure, in which strength rather than the graces of architecture are most considered.

32. Whitehead, on east end of Whitehead Island, western entrance to Penobscot Bay, Maine.—A wooden water tank of about 4,000 gallons' capacity, for fog-signal purposes, was set up at the station. Repairs were made to the boilers and fog-signal machinery, and minor repairs were made to the buildings.

—. *Two-Bush Island, southeast point, entrance to West Penobscot Bay, seacoast of Maine.*—The following statement, made in the Board's last annual report, is renewed:

The establishment of a light-station here, at a cost not exceeding $19,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

NOTE.—An appropriation of $19,000 was made in the sundry civil appropriation act approved August 18, 1894, for the establishment of this light-station. The work will be taken in hand at an early day.

First District.

33. Owls Head, on west side of Penobscot Bay, south side of entrance to Rockland Harbor, Maine.—Materials for an oil house were landed by the tender *Clover*, and the walls were built. Repairs were made to the fog-bell machinery. Materials for a boathouse and boat slip were landed by the tender *Myrtle*.

34. Rockland Breakwater, entrance to Rockland Harbor, Maine.—The lights were moved to a new beacon near the end of the finished work of the breakwater. Repairs were made to the illuminating apparatus.

35. Browns Head, entrance to Fox Island Thoroughfare, Maine.—Materials for a boathouse and boat slip were landed at the station.

37. Negro Island, on southeast end of island, south side of entrance to Camden Harbor, Maine.—Materials for an oil house were landed at the station.

50. Hendricks Head, on east side of mouth of Sheepscot River, Maine.—Minor repairs were made to the dwelling and boat slip. Materials for an oil house were landed at the station.

—. Ram Island day beacon, Kennebec River, Maine.—A day beacon in the nature of a tripod is needed here in fogs and during the thick vapors which lie over the land in the early part of the morning and during the night. Its cost, including the purchase of a site, will not exceed $300. The Board recommends that an appropriation of this amount be made therefor.

— Lower Kennebec River, Maine.—The following recommendation, made in the Board's last two annual reports, is renewed:

There were 3,137 arrivals of vessels in this river during the year, not counting the steamers which ply daily. The steamers *Kennebec*, 1,652 tons, and *Sagadahoc*, 1,413 tons, made ninety-six round trips each from Gardiner to Boston. Other passenger steamers ply on the river from Bath to Augusta, Boothbay, and Popham Beach, and intermediate places. The number of passengers carried was 232,150. Seventeen tugs were engaged on the river in towing. Thirty-nine vessels of 32,063 gross tons were built on the river, valued at $50 per gross ton, or, say, $1,603,150. The vessels arriving will average 450 tons. Some 24 feet draft can be carried to Thwings Point, 6 miles above Bath, 16 feet draft from Thwings Point to Gardiner, and 8 feet from Gardiner to Augusta. The Kennebec River is kept open by the towboats during the winter from Bath to the sea. Above Bath the buoys are taken up about November 20, and the river is likely to freeze at any time after this date. The ice usually goes out early in April. The river not only has the sea fogs, which extend to Bath, but its own river fog or mist, which is dense and at times low down. On dark nights it is sometimes impossible to tell where the water ends and the shore begins. The Light-House Establishment maintains no lights or fog signals in the Kennebec, but the Kennebec Steamboat Company and the towboat companies have united for many years in maintaining lanterns hung on the buoys at turning points or other difficult places. The above facts establish, in the Board's opinion, the necessity for and advisability of increasing the aids to navigation in the Kennebec River, and it recommends the establishment of the following-named lights:

On the southwest point of Perkins Island a fixed red lens-lantern light, with a white sector to the northward, and a fog bell struck by machinery, at an estimated cost of $5,700.

First District.

At Squirrel Point a fixed red light from a lens lantern, with a white sector to the southward, at an estimated cost of $4,650.

At Doubling Point a red lens-lantern light, showing up and down the river, with a fog bell, and one-half mile east from the point white range lights, not less than 500 feet apart, to mark the channel from Ram Island to Fiddlers Reach, at an estimated cost of $6,300.

At Ames Ledge, just above Thwings Point, a red lens lantern, mounted on the wooden spindle, which is maintained there during the navigable season, at an estimated cost of $75.

It is estimated that these light-stations can be established for not exceeding $16,725.

The Board now recommends that an appropriation be made of the amount named, and, pending acquisition of title to the sites for the lights, that the Board be authorized to lease the land needed for the sites. If this is done possession can be had almost immediately. It may take two years or more to acquire title by purchase.

53. *Halfway Rock, on Halfway Rock, nearly midway between Cape Small Point and Cape Elizabeth, Maine.*—A new revolving machine was installed in place of the old one, and minor repairs were made to the illuminating apparatus.

54, 55. *Cape Elizabeth, on Cape Elizabeth, Maine.*—A new siren boiler was installed in place of the old one, and repairs were made to the machinery. The following recommendation, made in the Board's last three annual reports, is renewed:

Until the resignation of the principal keeper, about two years ago, his wife was an assistant keeper, so that there were but three families to be accommodated in the three single dwellings at the station. This arrangement is changed, and there are now four separate families at the station, and two families are crowded into a dwelling adapted in size and arrangement to only one family. The two towers are more than 900 feet apart; two of the dwellings are near the northeast and one near the southwest tower. A fourth dwelling is very urgently needed near the latter to properly and conveniently house in the severe winter weather of that climate the second of the two assistants who attends the light in it. Besides a first and a second order light, the station has a first-class fog signal, and an additional dwelling is imperatively needed in the best interests of the service. It is estimated that one can be built for $3,300, and it is recommended that an appropriation of this amount be made therefor.

—. *Spring Point Ledge, Portland Harbor, Maine.*—The following recommendation, made in the Board's last three annual reports, is renewed:

A bell should be placed on Spring Point Ledge, Portland Harbor, at a point where it would mark that dangerous ledge, which lies in bold water at the edge of the channel. It would also mark a turning point, and would be of great service to vessels making their way into Portland Harbor in thick weather, going either to the wharves, to an anchorage in Diamond Island Roads, or to the westward of Fort Gorges. At present they have to grope their way unaided after leaving the bell buoy off Cushing Island Point. When the sea is exceptionally calm this buoy does not ring, and there is no guide for vessels from the time they pass the trumpet at Portland Head. With a bell on Spring Point Ledge, vessels could always change their course there in thick weather, without depending, as they now do, on their

First District.

time from the bell buoy or from Portland Head, 2 miles distant. The difficulty is increased by the liability of the reckoning being lost in meeting other vessels which throng the harbor, and some of which even anchor in the channel in the midsummer season, when the fogs are most dense and frequent.

The peril to vessels in thick weather is also somewhat increased by the tendency of a current, issuing at some states of the tide between Cushing (Bangs) Island and Fort Scammel, to set vessels toward the Spring Point side of the channel, and of the ebb current to set them in a southerly direction on to Spring Point Ledge.

Seven steamship companies own steamers which enter Portland Harbor. They embrace the regular coastwise lines, one foreign line, and the steamers plying between Portland and places in the immediate vicinity which are of daily resort in summer. These companies claim that 518,362 passengers were carried into Portland by their steamers last year, as follows:

Casco Bay Company	317,285
Portland Steam Packet Company	75,482
International Steamship Company	40,325
Maine Steamship Company	4,495
Harpswell Steamboat Company	6,000
Portland and Boothbay Steamboat Company	3,000
Steamer *Greenwood*	36,000
Steamer *S. E. Spring*	35,000
Allan Steamship Line	775
Total	518,362

In view of the excellence and importance of the harbor, the very large number of vessels which annually resort to it for refuge, the great number of passengers carried into it, which will doubtless steadily increase with the increasing number of people who resort to the coast of Maine in midsummer, and the frequency and density of the fogs at the very period when the passenger traffic is greatest, it is recommended that provision be made for the establishment upon Spring Point Ledge of a fog bell and a light of the fifth order, in a depth of water not to exceed 12 feet at mean low tide, and the building of a structure of about the type and diameter of those at Crabtree Ledge and Goose Rocks, Maine. It is estimated that this can be done for $45,000, and it is recommended that an appropriation of this amount be made for that purpose.

61. Boon Island, seacoast of Maine.—The following recommendation, made in the Board's last three annual reports, is renewed:

There are at this station one keeper and two assistants, and but two sets of quarters in one double dwelling. The second assistant keeper has to board either with the family of the keeper or with that of the first assistant keeper. This forced arrangement is unsatisfactory to all, and is quite unfavorable to the retention of a second assistant of the needed qualifications. The station is isolated and exposed, the tower is tall, and this second-order light is an important one. A third dwelling, which is urgently needed, it is estimated can be built for $3,400. It is therefore recommended that an appropriation of this amount be made therefor.

64. Seavys Island, on the extreme southwest point of Seavys Island, Maine, entrance to Portsmouth Harbor, New Hampshire.—Two fixed red tubular lanterns were displayed from a red post from September 25, 1893. On April 10, 1894, a post range light was exhibited in connection with the other lights.

First District.

REPAIRS.

Repairs more or less extensive were made during the year at the following-named stations:

3. Lubec Channel, Me.
4. West Quoddy Head, Me.
5. Little River, Me.
6. Avery Rock, Me.
8. Moose Peak, Me.
9. Moosabec Reach, Me.
10. Nash Island, Me.
12. Petit Manan, Me.
14. Winter Harbor, Me.
17. Crabtree Ledge, Me.
19. Great Duck Island, Me.
20. Bear Island, Me.
25. Deer Island Thoroughfare, Me.
26. Goose Rocks, Me.
27. Eagle Island, Me.
36. Indian Island, Me.
39. Dice Head, Me.
41. Tennant Harbor, Me.
42. Marshall Point, Me.
43. Monhegan Island, Me.
44. Manana Island, Me.
45. Franklin Island, Me.
46. Pemaquid Point, Me.
47. Ram Island, Me.
49. Cuckolds fog-signal station, Me.
52. Seguin, Me.
56. Portland Head, Me.
58. Wood Island, Me.
59. Goat Island, Me.
60. Cape Neddick, Me.
62. Whaleback, N. H.
65. Isles of Shoals, N. H

SURVEYS.

Plans of the light-house land, showing in detail the contours and buildings, with separate plots of the buildings on a larger scale, were made of the following stations:

27. Eagle Island.
28. Pumpkin Island.
32. Whitehead (new buildings).
33. Owls Head.
35. Browns Head.
36. Indian Island.
37. Negro Island.
40. Fort Point.
41. Tennant Harbor.
43. Monhegan Island.
44. Manana Island fog-signal station.
45. Franklin Island.
46. Pemaquid Point.
47. Ram Island.
48. Burnt Island.
50. Hendricks Head.

Topographical surveys, with location of contours and buildings, were made at the following stations:

28. Pumpkin Island.
36. Indian Island.
37. Negro Island.
40. Fort Point.
44. Manana Island fog-signal station.
45. Franklin Island.
47. Ram Island.
48. Burnt Island.

The light-house lands were surveyed, their boundaries were marked with stone posts or copper bolts, contours were located by plane table, and the buildings were measured for ground plans at:

27. Eagle Island.
33. Owls Head.
35. Browns Head.
41. Tennant Harbor.
43. Monhegan Island.
50. Hendricks Head.

DAY OR UNLIGHTED BEACONS.

Gilpatrick Ledge, Mount Desert, Maine.—A 35-foot spindle, with spherical cage, was set on the ledge near the channel.

York Ledge, Maine.—A cage was put on the spindle.

First District.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

Experiments were made with the fog signals in this district, for which see report of fog-signal experiments, Second district.

4. West Quoddy Head, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 1,327 hours during the year, and consumed about 66 tons of coal.

7. Libby Islands, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 1,499 hours during the year, and consumed about 80 tons of coal. A larger water supply is necessary. The keeper has been forced to use salt water in the boiler for some time.

12. Petit Manan, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 1,955 hours during the year, and consumed about 72 tons of coal.

15. Mount Desert, Maine.—This third-class Daboll trumpet, in duplicate, was in operation some 1,379 hours during the year, and consumed about 6 tons of coal.

19. Great Duck Island, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 1,458 hours during the year, and consumed about 60 tons of coal.

30, 31. Matinicus Rock, Maine.—The signals of this station, a 10-inch and a 12-inch steam whistle, were in operation some 1,449 hours during the year, and consumed about 63 tons of coal.

32. Whitehead, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 2,272 hours during the year, and consumed about 73 tons of coal.

44. Manana Island, Maine.—This first-class Daboll trumpet, in duplicate, was in operation some 1,181 hours during the year, and consumed about 16 tons of coal.

49. Cuckolds Island, Maine.—This first-class Daboll trumpet, in duplicate, was in operation some 1,009 hours during the year, and consumed about 6 tons of coal.

52. Seguin, Maine.—This 10-inch steam whistle, in duplicate, was in operation some 1,405 hours during the year, and consumed about 60 tons of coal.

54, 55. Cape Elizabeth, Maine.—The signals are a second-class steam siren and a 12-inch steam whistle. They were in operation some 906 hours during the year, and consumed about 35 tons of coal.

56. Portland Head, Maine.—This second-class Daboll trumpet, in duplicate, was in operation some 939 hours during the year, and consumed about 11 tons of coal.

62. Whaleback, New Hampshire.—This third-class Daboll trumpet, in duplicate, was in operation some 947 hours during the year, and consumed about 6 tons of coal.

First District.

BUOYAGE.

There were established during the year 21 new buoys, including the 4 first-class can buoys established to mark the boundary line between Maine and New Brunswick. A spindle was erected on Gilpatrick Ledge, eastern entrance to Somes Sound, Mount Desert Island, Maine.

In conformity with section 4678 of the Revised Statutes of the United States the following changes were made in the coloring and numbering of the buoys in this district, viz:

Green Island Ledge buoy, Brothers Passage, Machias Bay, Maine, changed from a black spar No. 3 to a red spar No. 4.

Jones Ledge buoy, Sorrento Harbor, Maine, changed from a black spar No. 1 to a red spar No. 2.

North point of Greening Island buoy, Southwest Harbor, Mount Desert, Maine, changed from a red and black horizontal-striped spar to a red spar No. 10.

Steamboat Rock buoy, Eggemoggin Reach, Maine, changed from a red and black horizontal-striped spar to a red spar No. 10.

Waterman Ledge buoy, Fox Island Thoroughfare, Maine, changed from a red and black horizontal-striped spar to a red spar No. 6.

Spruce Point Ledge (north point) buoy, Linekins Bay, Maine, changed from a black spar No. 1 to a red spar No. 2.

Spruce Point Ledge (south point) buoy, Linekins Bay, Maine, changed from a red spar No. 6 to a black spar No. 1.

South Powderhorn buoy, Sheepscot River, Maine, changed from a black spar No. 1 to a red spar No. 2.

Ebenecook buoy, Ebenecook Harbor, Maine, changed from a red spar No. 2 to a black spar No. 1.

Also the following iron buoys in this district were changed to show nun buoys, properly colored and numbered, on the starboard side of the channel, and can buoys on the port side of it, viz:

Birch Point Ledge buoy, Pennamaquam River, Maine; name changed from Goose Island Ledge; buoy changed from a third-class can to a second-class nun, red No. 6.

Petit Manan Reef buoy off Petit Manan light, changed from a second-class can to a second-class nun, red No. 2.

Cross Island Ledge buoy, Machias Bay, Maine, changed from a second-class can to a second-class nun, red No. 2.

Randall Point Flats buoy, Machias River, Maine, changed from a second-class can to a second-class nun, red No. 4.

Gilchrist Rock buoy, Moosabec Reach, Maine, changed from a second-class nun to a third-class can, black No. 1.

Grindstone Ledge buoy, Winter Harbor, Maine, changed from a second-class can to a second-class nun, red No. 2.

First District.

Seal Harbor buoy, Mount Desert Island, Maine, changed from a second-class can to a first-class nun, red, No. 2.

Northern Triangles buoy, Two-Bush Channel, Maine, changed from a second-class nun to a second-class can, black No. 1.

Black Ledges (Roaring Bull) buoy, Metinic Island, Maine, changed from a first-class nun to a first-class can, black No. 1.

Old Cilley Ledge buoy, off Port Clyde, Maine, changed from a second-class can to a second-class nun, red No. 4.

Old Man Ledge buoy, off Georges Islands, Maine, changed from a second-class can to a second-class nun, red No. 6.

Inner Bay Ledges buoy (southern end), West Penobscot Bay, Maine, changed from a second-class can to a second-class nun, red No. 4.

Hay Island Ledge buoy, West Penobscot Bay, Maine, changed from a first-class nun to a first-class can, black No. 1.

Sheep Island Bar buoy, Owls Head Bay, Maine, changed from a first-class can to a first-class nun, red No. 2.

South point Steele Ledge buoy, Belfast Harbor, Maine, changed from a second-class can to a second-class nun, red No. 2.

Jack-knife Ledge buoy, entrance to Kennebec River, Maine, changed from a second-class nun to a second-class can, black, with J. K. in white letters.

Staniford Ledge buoy, Portland Harbor, Maine, changed from a second-class nun to a first-class can, black with S. L. in white letters.

Alden Rock buoy, off Cape Elizabeth, Maine, changed from a first-class nun to a first-class can, black with A. R. in white letters.

Trundy Reef buoy, off Cape Elizabeth, Maine, changed from a first-class nun to a first-class can, black with T. R. in white letters.

The Old Prince buoy, Cape Porpoise Harbor, Maine, changed from a second-class can to a second-class nun, red No. 2.

Stielman Rocks buoy, Portsmouth Harbor, New Hampshire, changed from a second-class nun to a second-class can, black No. 3.

Other changes were made as follows:

Popes Folly Ledge buoy, Friar Roads, St. Croix River, Maine, changed from a red and black horizontal-striped spar to a second-class can, black No. 9, and placed about 100 feet eastward of its former position.

Middle Ground (Quoddy Roads) buoy, Lubec Narrows, Maine, changed from a spar, red No. 2, to a first-class nun, same marks.

Jumper Ledge buoy, Moosabec Reach, Maine, changed from a red and black horizontal-striped spar to a second-class nun, same marks.

Egg Rock whistling buoy, Frenchman Bay, Maine, was permanently discontinued.

Fairway buoy, Cranberry Island Passage, Maine, changed from a second-class nun, with black and white perpendicular stripes, to a second-class can with same marks.

Spring Point Ledge buoy, Portland Harbor, Maine, changed from a

first-class can to a first-class spar, black No. 3, and moored 150 yards northeast of the ledge.

White Island Ledge bell buoy, Isles of Shoals Harbor, New Hampshire, was made a permanent aid to navigation.

DEPOTS.

Little Diamond Island, Portland Harbor, Maine.—The wharf, coal shed, and buildings at this station are in excellent condition. The boundary fence was rebuilt, and the dolphin near the southern end of the wharf was renewed.

Bear Island, Mount Desert, Maine.—The wharf was extended shoreward on the northerly side, giving an additional area of about 2,000 square feet, which was much needed for the handling of buoys, which are repaired and painted at this depot. Minor repairs were made to the wheeling stage.

Whitehead, Maine.—A plank floor was laid in the coal shed.

TENDERS.

The Lilac.—This steamer was continuously, usefully, and economically employed during the year. She was placed on the marine railway in September, 1893, and June, 1894, her bottom cleaned and painted; minor repairs were made to the engine and hull; the boiler was repaired and the furnaces were fitted to burn anthracite coal. In November, 1893, she was employed eight days in placing four first-class iron buoys to mark the trial course of the cruiser *Columbia* between Cape Ann and Cape Porpoise. This district is growing so fast that the tender finds it difficult to change, replace, paint, and keep in order the 666 buoys and 104 beacons, spindles, and tripods; to supply and inspect the light-stations; to transport keepers and families; to make examination of ground for buoyage, to replace or repair buoys which are constantly going adrift, and to land the coal at the light and fog-signal stations. The work is now so exacting and severe that it is very difficult to enlist or retain a crew of deck hands or firemen. This frequent change of crew seriously affects the efficiency of the tender. During the year she steamed 16,150 miles and consumed about 956 tons of coal.

SECOND DISTRICT.

The Second district extends from Hampton Harbor, New Hampshire, to, but does not include, Elisha Ledge, off Warren Point, Rhode Island, and embraces all the aids to navigation on the coast of Massachusetts except a small portion of Narragansett Bay and Taunton River.

Inspector.—Commander George F. F. Wilde, U. S. Navy, to November 30, 1893; Commander Francis M. Green, U. S. Navy, from November 30, 1893.

Engineer.—Maj. William R. Livermore, Corps of Engineers, U. S. Army.

In this district there are—

Light houses and lighted beacons	70
Light-ships in position	9
Light-ships for relief	2
Day or unlighted beacons	72
Fog signals operated by steam or hot-air engines	9
Fog signals operated by clockwork	10
Lighted buoys in position (gas)	5
Whistling buoys in position	12
Bell buoys in position	16
Other buoys in position	508
Ice buoys for winter use	14
Steamers *Verbena*, *Geranium*, and *Azalea*, buoy tenders and for supply and inspection	3
Steamer *Myrtle*, for construction and repair in the First and Second districts	1

LIGHT-HOUSES.

68. *Newburyport Harbor, Plum Island, Merrimack River, Massachusetts.*—A brick oil house was built.

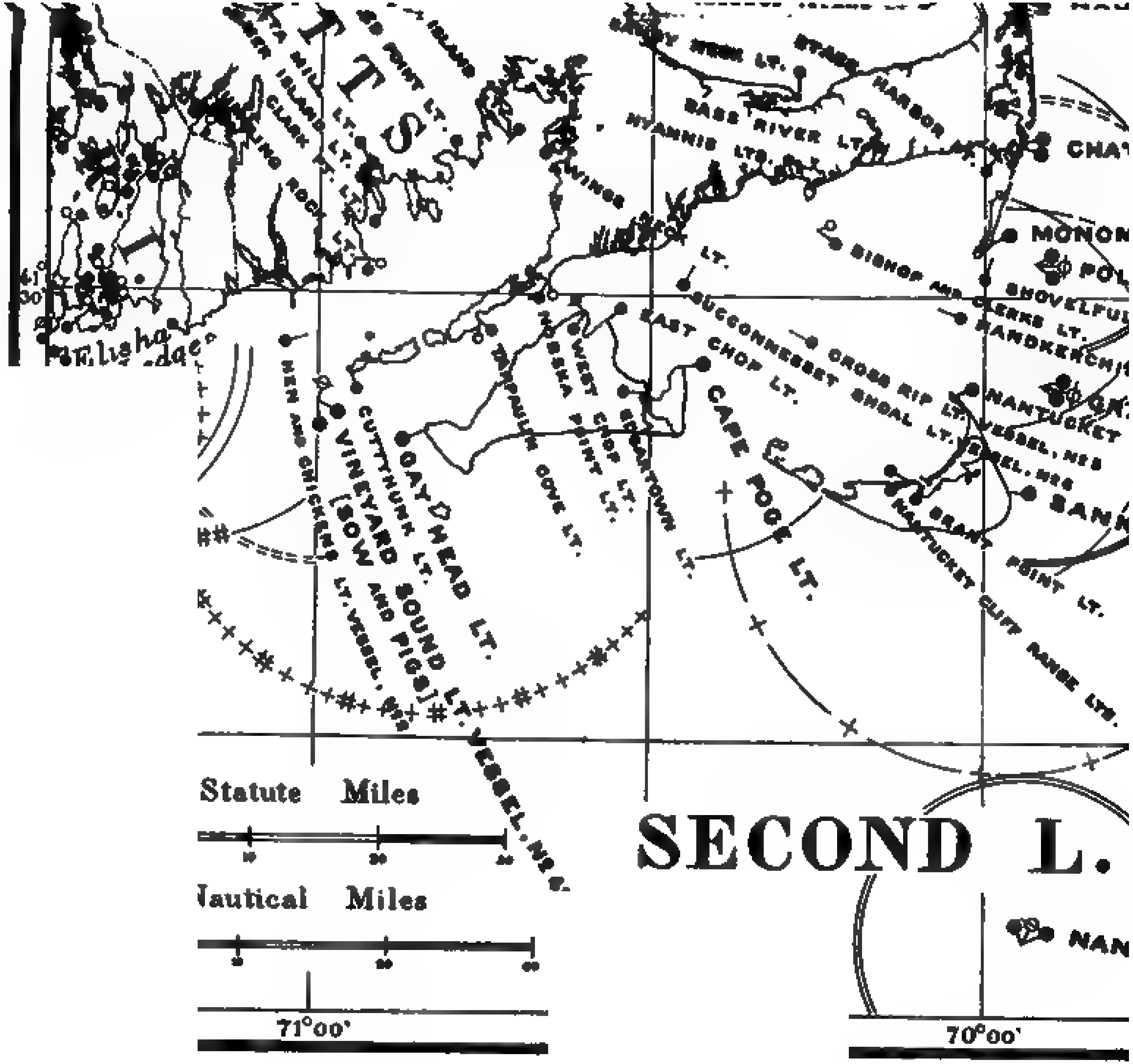
74. *Straitsmouth, on northeast point of Straitsmouth Island, north side of Cape Ann, Massachusetts.*—The footbridge from the dwelling to the tower was rebuilt, the boat slip was repaired, and minor repairs were made to the tower and dwelling.

75, 76. *Cape Ann, Thatcher Island, Massachusetts.*—The sanitary condition of all the dwellings was greatly improved by building nearly 400 feet of drains. Repairs were made to the dwellings, towers, and to the illuminating apparatus.

78. *Tenpound Island, in Gloucester Harbor, Massachusetts.*—The westerly side of the dwelling was rebuilt, and various repairs were made.

79. *Baker Island, north part of Baker Island, Massachusetts.*—A drain was laid, and a cistern for domestic water supply for the assistant's house was built. A hard-pine boat slip, 122 feet long, and a brick oil house were built.


71°00'
70°30'
SHIRE
Hampton Harbor
NEWBURYPORT HARBO
ANNISQUAM HARBOR
STRAITSMOUTH
CAPE ANN
TENPOUND ISLAND LT.
EASTERN POINT LT
BAKER ISLAND LTS.
MARBLEHEAD LTS.
EGG ROCK LT.
DEER ISLAND LT.
BOSTON LTS.
BOSTON LT. VESSE
MINOTS LEDGE
BREAKWATER LT.
RACE POINT LT.
WOOD END LT.
LONG POINT LT.
DUXBURY PIER LT.
PLYMOUTH LTS.
[GURNET]
BILLINGSGATE ISLAND LT.
MAYO BEACH LT.
NAUSET


SECOND L.
BASS RIVER LT.
HYANNIS LTS.
STAGE HARBOR LT.
BISHOP AND CLERKS LT.
SHOVELFUL
HANDKERCHIEF
MONOMOY
CROSS RIP LT. VESSEL, NO 6
NANTUCKET
SUCCONNESSET SHOAL LT. VESSEL, NO 6
EAST CHOP LT.
CAPE POGE LT.
EDGARTOWN LT.
WEST CHOP LT.
NOBSKA POINT LT.
TARPAULIN COVE LT.
GAY HEAD LT.
CUTTYHUNK LT.
VINEYARD SOUND LT. VESSEL, NO 6
[SOW AND PIGS]
HEN AND CHICKENS LT. VESSEL, NO 6
BRANT POINT LT.
NANTUCKET CLIFF RANGE LTS.
Statute Miles
Nautical Miles
71°00'
70°00'
Elisha Ledge

Second District.

84. *Marblehead, entrance to Marblehead Harbor, Massachusetts.*—The following recommendation, made in the Board's last annual report, is renewed:

Marblehead has a deep capacious harbor, which is nearly landlocked. For nearly sixty years a light has been maintained to guide vessels in and out of this harbor, especially the fishermen, who, from the very nature of their business, find it necessary to enter and leave the harbor at any and all times, at night as well as by day. Many merchant vessels loaded with coal and general merchandise ply between this and other ports along the shore, and scores of yachts, with hundreds of pleasure seekers, make this their headquarters during the summer. The harbor when not properly lighted is difficult of approach, especially from the south and west. Mariners, ship owners, and others have complained for some years that the many dwellings lately built obscure the light. The difficulty has been partly overcome by showing a light from a lantern hoisted on a mast; but this is only a makeshift. The safety of commerce absolutely requires that a higher tower be erected. It is now proposed, therefore, to build a brick tower about 100 feet high, on the site of the present tower, at an estimated cost of $45,000, and it is recommended that an appropriation of this amount be made therefor.

87. *Minots Ledge, on the Outer Minot, one of the Cohasset Rocks, entrance to Boston Bay, Massachusetts.*—The new second-order lens, which flashes the number "143," was installed. (*See* Appendix No. III, page 233.) The new light was exhibited for the first time on May 1, 1894. Minor repairs were made to dwellings and tower.

—. *Spectacle Island, Boston Harbor, Massachusetts.*—The following recommendation, made in the last two annual reports, is renewed:

Boston is one of the most important commercial cities in the country. Its harbor is without sufficient aids to navigation. Among those most needed are range beacons on Spectacle Island to mark the center of the dredged channel from State Ledge toward the city, and to mark the turning point into the channel for vessels coming up from Nix Mate. The front beacon should be on a pyramidal wooden tower 13 feet high, the base being 8 feet above mean high water. The rear range should be on a similar tower 16 feet high, its base being about 35 feet above mean high water. The station would need a dwelling for the light-keeper, a fuel house, a boathouse, and a boat slip, with an acre of land for a light-house site and a right of way from it to the nearest road. It is estimated that the range lights can be established for not exceeding $9,350, and it is recommended that an appropriation of this amount be made therefor.

—. *South Boston range lights, Massachusetts.*—The following recommendation, made in the last two annual reports, is renewed:

Ranges should be established on the Marine Park Pier and at City Point, South Boston, to guide vessels coming up Boston Harbor from Nix Mate to State Ledge turn. The range at South Boston City Park should be a mast 50 feet high, with crosstrees 10 feet long, supporting a red lantern at each end. The range beacon at the Marine Park Pier should be a mast reaching about 30 feet above the driveway, supporting two red lanterns, one 6 feet above the other. It is estimated that the range lights can be established for not exceeding $1,000, and it is recommended that an appropriation of this amount be made therefor.

NOTE.—An appropriation of $1,000 was made for the establishment of these range lights in the sundry civil appropriation act approved on

Second District.

August 18, 1894. The proper measures have been taken for their establishment at the earliest day practicable.

—. *State Ledge, Boston Harbor, Massachusetts.*—The following recommendation, which has been made in the Board's last six annual reports, is renewed:

The ship channel, from the Boston wharves to Nix Mate Buoy, has no aids to navigation except buoys. Vessels find it very difficult in thick weather and at night to keep in the channel, and they are particularly perplexed to know just where to turn in the neighborhood of State Ledge and buoy No. 8, both in leaving and entering the harbor. Large excursion steamers, as well as steamers of the regular lines running out of Boston, frequently have to anchor in thick weather solely because they have no guide between Nix Mate buoy and the wharves. This greatly incommodes business men going and coming during the summer months when fogs are prevalent. The Board has recognized for a long time the necessity for a light and fog signal at this point, but has postponed action while the improvements in the channel of the harbor in charge of the United States engineers were in progress. Although these improvements have not yet been entirely finished they are practically concluded in that vicinity, and the Board is of opinion that the time has arrived when a light and fog signal ought to be established near buoy No. 8, or at or near State Ledge. It is estimated that it will cost $42,000 to establish a light and fog signal at this point.

It is recommended that an appropriation of this amount be made therefor.

95. Plymouth (Gurnet), on Gurnet Point, entrance to Plymouth Harbor, Massachusetts.—Repairs were made to the towers and dwellings, and 140 feet of drain was laid.

110. Monomoy Point, southern extremity of Cape Cod, Massachusetts.—A brick oil house was built, and various repairs were made.

128. Cape Poge, Marthas Vineyard, Massachusetts.—An iron railing was put in place on the deck around the lantern, and minor repairs were made.

—. *Butler Flat, New Bedford Harbor, Buzzards Bay, Massachusetts.*—The following recommendation, which was made in the Board's last five annual reports, is renewed:

The entrance near buoy No. 9, on the point of Butler Flat, is narrow, obscure, and difficult to find in snowstorms, fogs, and dark nights. If a light with a fog signal was placed on that point it would mark both the entrance and turning point; would guide vessels to an anchorage in the lower harbor, and, with the light on Palmer Island, would guide them clear of North Ledge, Henrietta and Hurricane rocks, in Buzzards Bay, and be of great service to the navigation of this important port. It is stated by the custom-house authorities that 1,814 vessels entered the port of New Bedford during 1887, not including yachts, fishing craft, or boats. It is also stated that the Vineyard Sound and Nantucket steamers took 75,000 passengers to and from this port and received $22,500 for freight carried. It is further stated that the New York propellers made 104 trips between New York and New Bedford, and received over $100,000 for freight carried. New Bedford is now said to be the third manufacturing city in Massachusetts, and the collector of the port states that about 500,000 tons of shipping came into the port during last year.

The Board, as stated in its last annual report, is of the opinion that the needs of commerce and navigation require the establishment of a light and fog signal at this

Second District.

point. It is estimated that they can be erected for $45,000, and it is recommended that an appropriation of this amount be made therefor.

A bill for this purpose was passed by the Senate on February 19, 1892, but it was not acted on by the House of Representatives at that session of Congress. The House, however, passed a similar bill on December 11, 1893, but it was not acted on by the Senate. The establishment of the light-station was authorized by the act approved on January 22, 1894, but no funds were provided. The Board therefore renews the recommendation that $45,000 be appropriated for this purpose.

REPAIRS.

At each of the stations named below repairs, more or less extensive, were made during the year:

71, 72. Ipswich, Mass.
81. Hospital Point, Mass.
82. Fort Pickering, Mass.
88. Boston, Mass.
90. Narrows, Mass.
91. Deer Island, Mass.
92. Long Island Head, Mass.
93. Scituate Breakwater, Mass.
96. Duxbury Pier, Mass.
97. Race Point, Mass.
98. Wood End, Mass.
99. Long Point, Mass.
101. Billingsgate Island, Mass.
103. Cape Cod, Mass.
104, 105, 106. Nauset Beach, Mass.
115. Sankaty Head, Mass.
117. Gay Head, Mass.
122. Bass River, Mass.
123. Bishop and Clerks, Mass.
124. Hyannis, Mass.
129. Edgartown, Mass.
130. East Chop, Mass.
131. West Chop, Mass.
132. Nobska Point, Mass.
133. Tarpaulin Cove, Mass.
137. Dumpling Rock, Mass.
138. Clark Point, Mass.
139. Palmer Island, Mass.
143. Bird Island, Mass.

SURVEYS.

The light-house lands were surveyed, their boundaries were marked with stone posts and large stakes, contours were located by plane table, and the buildings were measured for ground plans at—

71. Ipswich.
72. Ipswich Beacon (shifting site).

Topographical surveys with location of contours and buildings were made at—

78. Tenpound Island.

Tracings of plans previously drawn were made for a number of stations.

LIGHT-SHIPS.

—. *Boston light-vessel, entrance to Boston Harbor, Massachusetts.*—The following recommendation, which was made in the Board's last two annual reports, is renewed:

A vessel moored about 6 nautical miles E. by S. of Boston light, showing two red lights, would be of great value to incoming vessels. The well-known difficulty in determining the location of the Boston light, when approaching in thick weather,

Second District.

and the doubtful utility of the bell at Minots Ledge are strong reasons why this aid to navigation should be established. It is estimated that a first-class light-ship with steam fog signal and auxiliary steam moving power would cost $70,000, and it is recommended that an appropriation of that amount be made therefor.

NOTE.—An appropriation of $35,000, with authority to contract for not exceeding $70,000, was made by the sundry civil appropriation act approved on August 18, 1894, for the construction of this light-vessel.

Plans and specifications are now being prepared for the new light-ship, and in a short time a contract will be executed for her construction. It is estimated, as before stated, that she will cost not to exceed $70,000. It is therefore recommended that the additional $35,000 be appropriated and made immediately available.

109. *Pollock Rip light-vessel, No. 47, off Chatham, Cape Cod, Massachusetts.*—This vessel has been on her station during the year. She is in good condition.

111. *Shovelful Shoal light-vessel, No. 3, off Monomoy Point, Cape Cod, Massachusetts.*—This vessel has not been moved from her station during the year. Slight repairs were made to one boat.

112. *Handkerchief light-vessel, No. 4, Nantucket Sound, Massachusetts.*—The ship has been on her station all the year. A new trysail was supplied, also some galley ware. She is in good condition.

113. *Great Round Shoal light-vessel, No. 42, off Nantucket, Massachusetts.*—This vessel has not left her station during the year. One boat was repaired and galley ware and engineers' supplies have been furnished. She requires new boilers and some repairs to her hull.

116. *Nantucket New South Shoal light-vessel, No. 54, about 30 miles south of Nantucket, Massachusetts.*—This vessel has not left her station during the year. She is in fairly good condition. A new vessel No. 58, just built at Toledo, Ohio, is to replace this ship on this station.

NOTE.—Light-vessel No. 58 was finished and placed on this station in August, 1894, relieving light-vessel No. 54 from that duty.

126. *Cross Rip light-vessel, No. 5, Nantucket Sound, Massachusetts.*—The ship has remained on her station all the year. The bell standard has been repaired, and other slight repairs have been made.

127. *Succonnessett Shoal light-vessel, No. 6, Nantucket Sound, Massachusetts.*—This ship was on her station the whole year. Stovepipe and some stove linings were supplied.

134. *Vineyard Sound light-vessel, No. 41, western entrance to Vineyard Sound, Massachusetts.*—This vessel is in fairly good condition, although her boiler is showing signs of weakness. She has been on her station all the year. On October 23, 1893, she was struck by a tow of barges owned by the Central Railroad of New Jersey, damaging the rail and bulwarks and staving a boat. Repairs were made on the station at the expense of the railroad company by mechanics sent from New Bed-

ford. Patent riding stoppers were put in, a boat was repaired, galley ware and engineers' supplies were furnished and medicine chest was replenished.

135. Hen and Chickens light-vessel, No. 2, entrance to Buzzards Bay, Massachusetts.—This vessel was brought in from her station to New Bedford on September 2, 1893, for repairs. During this time she was replaced by relief light-ship No. 9. She was replaced on her station on October 11; while at New Bedford she was hauled out on the railway, was calked where necessary, and repairs were made to her copper, windlass, hawse pipes, scuppers, rudder, and bell.

Relief light-vessel, No. 9.—She was on Hen and Chickens light-station from September 2 to October 12, 1893, while the vessel which belonged there was under repairs at New Bedford. Galley ware was supplied.

Relief light-vessel, No. 39.—This vessel remained at Woods Hole light-house depot during the year. Some small repairs were made.

DAY OR UNLIGHTED BEACONS.

All beacons are in good condition, except Fivepound Island, Gloucester Harbor, which was upset by the ice.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

75. Cape Ann, Massachusetts.—This 10-inch steam whistle was in operation some 554 hours and consumed about 37 tons of coal.

88. Boston, Massachusetts.—This first-class steam siren was in operation some 709 hours and consumed about 55 tons of coal.

97. Race Point, Massachusetts.—This 12-inch steam whistle was in operation some 593 hours and consumed about 37 tons of coal.

103. Cape Cod, Massachusetts.—This first-class Daboll trumpet was in operation some 688 hours and consumed about 8½ tons of coal.

109. Pollock Rip light-vessel, No. 47, Massachusetts.—This 12-inch steam chime whistle was in operation some 859 hours and consumed about 106 tons of coal.

113. Great Round Shoal light-vessel, No. 42, Massachusetts.—This 12-inch steam whistle was in operation some 791 hours and consumed about 85 tons of coal.

116. Nantucket New South Shoal light-vessel, No. 54, Massachusetts.—This 12-inch steam whistle was in operation some 1,027 hours and consumed about 137 tons of coal.

131. West Chop, Massachusetts.—This 10-inch steam whistle was in operation some 565 hours and consumed about 25 tons of coal.

134. Vineyard Sound light-vessel, No. 41, Massachusetts.—This 12-inch steam whistle was in operation some 1,182 hours and consumed about 105 tons of coal.

Second District.

BUOYAGE.

In July the gas buoy which marked the wreck of the *Alva*, in Pollock Rip Slue, was removed, the wreck of the yacht having been blown up. In October, Canapitsit Channel was buoyed out by the placing of four buoys. One new buoy was established in Hyannis Harbor. In November, gas buoys were established on the north end of Centurion, Boston Harbor, and at Harding Ledge, Boston Bay; January 5, a new buoy was placed to mark an eight-foot spot in the south channel, Broad Sound, Boston Harbor; also a gas buoy was established at Nix Mate, Boston Harbor. In February, seven new buoys were established in Plymouth Harbor. In March, a new buoy was placed on Halftide Rock, Manchester Harbor. Iron spar ice buoys were substituted for a spar buoy on the east end of Hedge Fence Shoal and for a second-class can buoy at Cross Rip, Nantucket Sound.

The following-named whistling and bell buoys were lost during the year:

In December, 1893, the whistling buoy in Great Round Shoal Channel; in January, 1894, the Pollock Rip Slue whistling buoy, and in April, the whistling buoy off Gloucester Harbor. In February, the bell buoy in Pollock Rip Slue, and also from the same station another bell buoy in April. These losses were largely due to collisions with coal barges in tow of tugs.

DEPOTS.

Woods Hole, Little Harbor, Massachusetts.—The roof of the dwelling was reshingled and minor repairs to other parts were made.

Lovells Island, Boston Harbor, Massachusetts.—A new foundation and underpinning were laid under the dwelling, two rooms were replastered, a cellar was made, and a cistern of about 1,600 gallons' capacity was built.

Machine and lamp shop, Boston.—Extensive repairs were made to fog-signal machinery and illuminating apparatus.

TENDERS.

The Geranium.—This steamer was employed in buoy service and in inspecting and supplying light-stations. She steamed about 6,870 miles, and in so doing consumed some 786 tons of coal.

New tender.—The *Geranium* is so old and so crank that she can not be safely trusted at sea in bad weather. A first-class twin screw steamer is urgently needed in her place. It is estimated that such a vessel can be built for a sum not exceeding $85,000. Recommendation is made that an appropriation of that amount be made therefor.

The Verbena.—This aged steamer was laid up at Woods Hole light-

house depot from November 1, 1893, to April 10, 1894, but was busily engaged in buoy work from that time until the end of the fiscal year. She steamed about 4,557 miles, and in doing so consumed some 380 tons of coal.

The Azalea.—This steamer was engaged in buoy work, supplying light-ships, and the like. She steamed about 8,998 miles, and in doing so consumed some 893 tons of coal.

The Myrtle.—This steamer, used for construction, repairs, and general service in the First and Second districts, was taken out on the railway in October, 1893, when minor repairs were made to her shoe, sheathing material, and rudder. In March, 1894, the pilot house was rebuilt, a new cylinder head with tailrod was provided and put in place, and the engine was overhauled and repaired. An electric-lighting plant was installed during the fall and winter of 1893–'94, and the apparatus for an electric launch was purchased. The boiler was repaired, but is in an unsatisfactory condition, which causes much delay and constant repairs. A new boiler is needed. During the year she steamed about 13,200 miles and consumed some 788 tons of coal.

The Clover.—This schooner was used for construction, repairs, and general service in the First and Second districts from February 20, 1894, to June 30, 1894, when she was temporarily turned over to the Coast and Geodetic Survey.

EXPERIMENTS FOR THE IMPROVEMENT OF FOG SIGNALS.

A series of tests of fog signals were made in connection with the regular work of the tenders on their way to and from light-stations for the improvement of the fog-signal service. Data of this kind was collected from time to time whenever opportunity presented itself and it is now available.

A list of the regular fog signals of the First and Second districts, which have been tested, is as follows:

Sirens: First class, Boston light, Massachusetts; second class, Cape Elizabeth, Maine.

Whistles: 12-inch, Cape Elizabeth, Maine, and Race Point, Massachusetts; 10-inch, Libby Islands, Petit Manan, Matinicus Rock, Whitehead, and Seguin, Maine, and Cape Ann, Massachusetts.

Trumpets: First class, at Manana Island; second class, at Portland Head; third class, at Mount Desert Rock and Cuckolds, Maine, and Whaleback, New Hampshire.

Bells: Deer Island Thoroughfare, Goose Rocks, Owls Head, Pond Island, and Halfway Rock, Maine, and Eastern Point, Baker Island, and Minots Ledge, Massachusetts.

Several bells were broken in testing the weight of the blow which could most advantageously be given. Three of these were of bell

Second District.

metal and one was of a steel composition. The weights and descriptions follow:

Weight.	Force of blow.	Number of blows required to break.
Pounds.	*Ft. lbs.*	
960	178	11,000
1,040	148	(?)
4,000	350	18,000
1,000	150	24

Further tests are required to determine the resistance of the steel bell.

These bells were mounted on a wooden frame, and struck by a cast-iron hammer operated by a striking machine attached to a small coal-oil engine. The first named were taken about the districts on the tenders and compared with the signals regularly used.

At Boston light-station experimental signals were set up and several tests made. These include, beside the regular sirens, 12-inch, 10-inch, 8-inch, and 6-inch steam whistles mounted at different elevations, a third-class Daboll trumpet, and a large trumpet, built on the general plan of a Daboll trumpet, with such variations as were found necessary on account of its great size. This trumpet has a 10-inch reed. The Daboll trumpet has been supplied with a wooden horn, 55 feet in length. The effect of this addition was carefully noted.

The Shipman and Kane oil engines have been compared with motors now in use both as to efficiency and economy.

The following is a summary of the tests made:

Libby Islands, Maine, January 26, 1894: Ten-inch whistle.

Petit Manan, Maine, November 19, 1893: Ten-inch whistle, 1,000-pound bell, and the tender *Myrtle's* 6-inch whistle.

Mount Desert Rock, Maine, November 21, 1893: Third-class Daboll trumpet, the *Myrtle's* 6-inch whistle, and 1,000-pound bell.

Deer Island Thoroughfare, Maine, June 2, 1894: Regular fog bell.

Goose Rocks, Maine, June 2, 1894: Regular fog bell.

Matinicus Rock, Maine, September 27, 1893: Ten-inch whistles, regular fog bell, and the *Myrtle's* 6-inch whistle.

Whitehead, Maine, September 8 and 9, 1893: Ten-inch whistles, 960-pound bell, and the *Myrtle's* 6-inch whistle; September 28, 1893, 10-inch whistle, 1,040-pound bell, and the *Myrtle's* 6-inch whistle; June 13, 19 and 21, 1893, 10-inch whistle.

Owls Head, Maine, September 7 and 8, 1893: Regular 1,000-pound bell, 960-pound bell, and the *Myrtle's* 6-inch whistle: June 13 and 14, 1894, regular 1,000-pound bell.

Manana Island, Maine, June 21, 1894: First-class Daboll trumpet.

Cuckolds, Maine, November 16, 1893, and June 21, 1894: Third-class Daboll trumpet.

Second District.

Seguin, Maine, September 14, 15, and 17, 1893: Ten-inch whistle, 960-pound bell, and the *Myrtle's* 6-inch whistle; June 22, 1894, 10-inch whistle.

Halfway Rock, Maine, June 12, 1894: Regular fog bell.

Cape Elizabeth, Maine, September 11 and 12, 1893: Second-class siren, 12-inch whistle, 960-pound bell, and the *Myrtle's* 6-inch whistle; September 25 and 26, 1893, second-class siren and 12-inch whistle.

Portland Head, Maine, September 4, 1893: Second-class Daboll trumpet and 960-pound bell.

Boon Island, Maine, September 23, 1893: Regular fog bell.

Whaleback, New Hampshire, September 23, 1893: Third-class Daboll trumpet, 1,000-pound bell, and the *Myrtle's* 6-inch whistle.

Cape Ann, Massachusetts, November 14, 1893, and April 5, 6, and 7, 1894: Ten-inch whistles.

Eastern Point, Massachusetts, May 4 and 5, 1894: Two thousand-pound bell.

Baker Island, Massachusetts, September 22, 1893: Regular 1,000-pound bell.

Minots Ledge, Massachusetts, May 8, 9, 10, 11, and 12, 1894: Regular 1,000-pound bell and experimental 1,000-pound bell.

Boston Light, Massachusetts, October 30 and 31, 1893: First-class siren; January 23, 1894, 4,000-pound bell and 1,000-pound bell; January 31, 1894, first-class siren, 4,000-pound bell and 1,000-pound bell; February 7, 1894, first-class siren (air), first-class siren (steam), large Daboll trumpet, third-class Daboll trumpet, 10-inch whistle, 4,000 and 1,000 pound bells; February 28, 1894, first-class siren (steam), first-class siren (air), 10-inch and 6-inch whistles, 4,000 and 1,000 pound bells; March 22, 1894, 4,000-pound bell, third-class Daboll trumpet, with 50-foot wooden extension; March 24, 1894, 4,000-pound bell, 1,000-pound bell in midstream and on scow; March 29, 1894, first-class siren (steam), first-class siren (air), 10-inch whistle, 8-inch whistle, 4,000 pound bell, and cannon; April 24, 25, 26, 27, and 28, 1894, 4,000-pound bell, third-class Daboll trumpet, with extension; May 1, 1894, third-class Daboll trumpet, with extension; May 11, 1894, 4,000-pound bell, third-class Daboll trumpet, with 50-foot extension.

Race Point, Massachusetts, November 10 and 11, 1893: Ten and 12 inch whistles.

The results of these tests have suggested various improvements in the fog-signal service, pointing to a gain in the efficiency of the signals and a reduction in the cost of maintenance. A detailed report of the tests, with plots of the sounds of various signals, conclusions, and recommendations, will be found in Appendix V to this report.

THIRD DISTRICT.

The Third district includes and extends from Elisha Ledge, off Warren Point, Rhode Island, to a point on the coast of New Jersey, opposite Shrewsbury Rocks, and embraces all aids to navigation on the sea and sound coast of Rhode Island, Connecticut, and New York, and of New Jersey above the Highlands of Navesink; Mount Hope, Narragansett, and New York bays; Providence, Connecticut, Thames, Raritan, and Hudson rivers; Whitehall Narrows, and lakes Champlain and Memphremagog.

Inspector.—Capt. Winfield S. Schley, U. S. Navy.

Engineer.—Maj. David P. Heap, Corps of Engineers, U. S. Army.

There are in this district—

Light-houses and beacon lights, including 95 post lights	239
Light-ships in position	7
Light-ships for relief	3
Day or unlighted beacons	41
Fog signals operated by steam or hot-air engines	16
Fog signals operated by clockwork	50
Electric buoys	7
Gas-lighted buoys	3
Whistling buoys in position	5
Bell buoys in position	19
Other buoys in position	573
Steamer *Armeria*, used for supplying the light-stations of the Atlantic and Gulf coasts	1
Steamers *John Rodgers* and *Cactus*, buoy tenders, and for supply, inspection of light-stations, and for repair of the cable, etc., of the electric-lighted buoys	2
Steamer *Gardenia*, buoy tender and for freight	1
Steamers *Mistletoe* and *Rose*, used for works of construction and repair of light-stations, fog signals, and day beacons	2
Steamer *Nettle*, for works of construction and repair on Lake Champlain	1

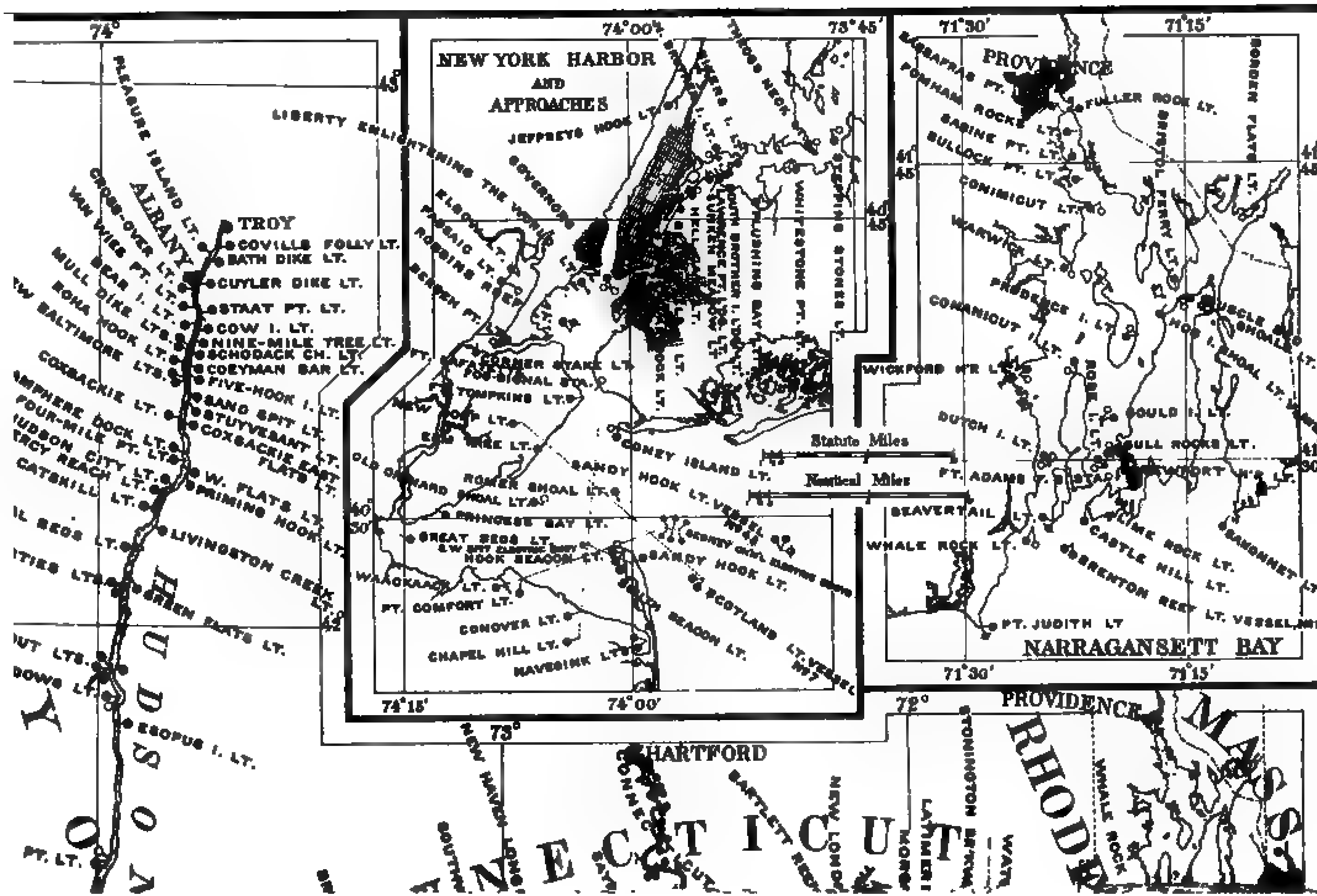
LIGHT-STATIONS.

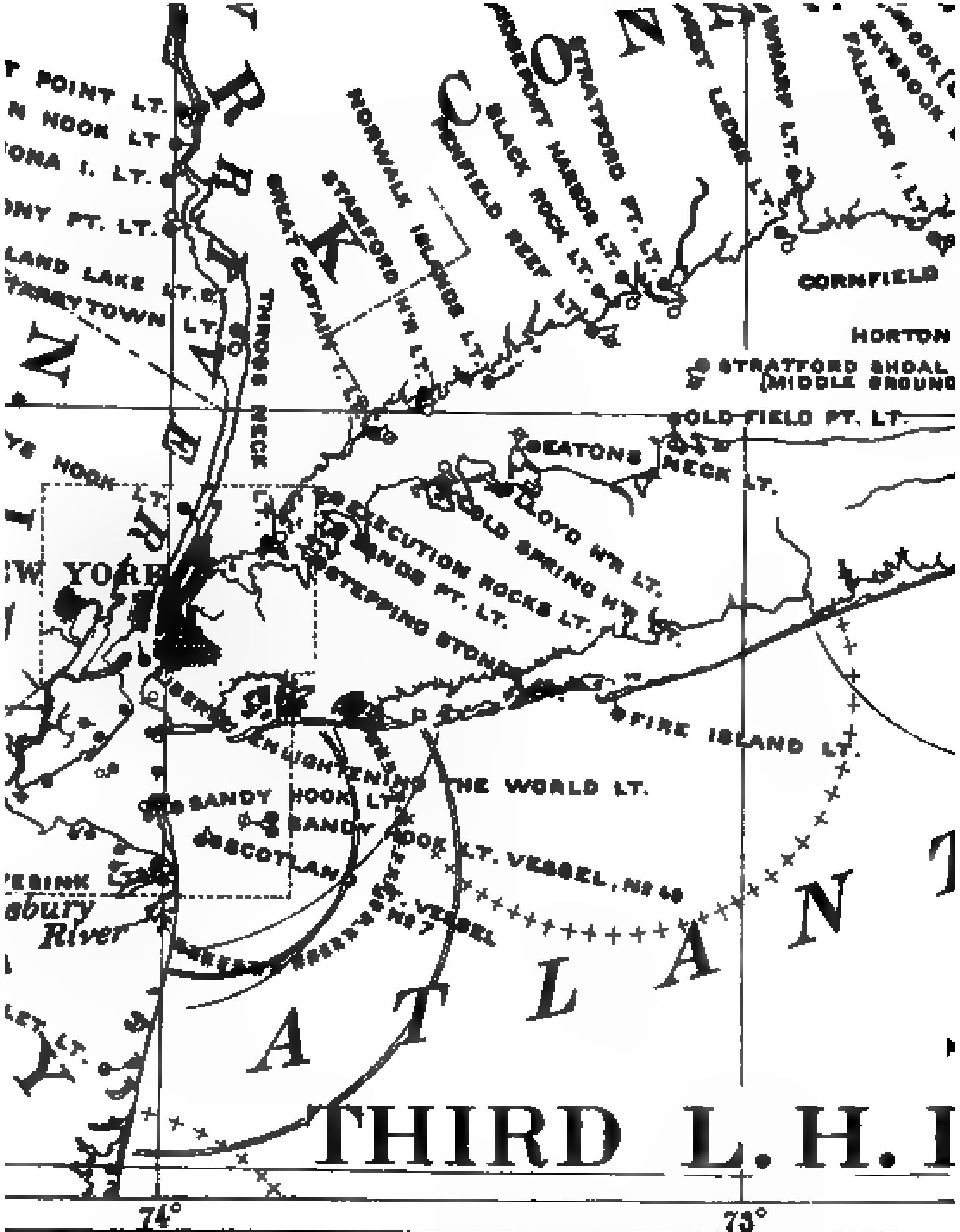
—. *Plum Beach, Narragansett Bay, Rhode Island.*—The following recommendation, made in the Board's last two annual reports, is renewed:

> The great sound steamers plying between Providence, R. I., and New York, N. Y., find navigation during fog quite hazardous. In avoiding Dutch Island there is extreme danger of grounding on Plum Beach, as is shown by the recent grounding of the steamer *Pequot*. It is estimated that a proper light and fog signal can be established on Plum Beach for not exceeding $60,000, and it is recommended that an appropriation of this amount be made therefor.

153. *Dutch Island, on south end of Dutch Island, Rhode Island.*—New boatways were made and placed in position.

154. *Gull Rocks, on Gull Rocks, entrance to Newport Harbor, Rhode Island.*—New fender piles were fitted on the landing wharf.


NEW YORK HARBOR AND APPROACHES
NARRAGANSETT BAY
PROVIDENCE
TROY
ALBANY
HARTFORD
HUDSON
CONNECTICUT
RHODE
MASS.
Statute Miles
Nautical Miles
LIBERTY ENLIGHTENING THE WORLD
JEFFREYS HOOK LT.
GOVERNORS
CONEY ISLAND LT.
SANDY HOOK LT.
SANDY HOOK LT. VESSEL
SCOTLAND LT. VESSEL
ROMER SHOAL LT.
PRINCESS BAY LT.
GREAT BEDS LT.
CONOVER LT.
CHAPEL HILL LT.
NAVESINK LTS.
PT. COMFORT LT.
WHITESTONE PT. LT.
STEPPING STONES LT.
FLUSHING BAY LT.
THROGS NECK
COVILLE FOLLY LT.
BATH DIKE LT.
CUYLER DIKE LT.
STAAT PT. LT.
COW I. LT.
NINE-MILE TREE LT.
SCHODACK CH. LT.
COEYMAN BAR LT.
FIVE-HOOK I. LT.
SAND SPIT LT.
STUYVESANT LT.
COXSACKIE EAST FLATS LT.
W. FLATS LT.
PRIMING HOOK LT.
LIVINGSTON CREEK LT.
GREEN FLATS LT.
ESOPUS I. LT.
PLEASURE ISLAND LT.
CROSS-OVER LT.
VAN WIES PT. LT.
BEAR I. LT.
MULL DIKE LTS.
BOHA HOOK LT.
COXSACKIE LT.
CATSKILL LT.
SASSAFRAS PT. LT.
POMHAM ROCKS LT.
SABINE PT. LT.
BULLOCK PT. LT.
CONIMICUT LT.
WARWICK LT.
PRUDENCE I. LT.
CONANICUT I. LT.
WICKFORD H'R LT.
DUTCH I. LT.
FT. ADAMS
BEAVERTAIL LT.
WHALE ROCK LT.
PT. JUDITH LT.
FULLER ROCK LT.
BRISTOL FERRY LT.
BORDEN FLATS LT.
ROSE I. LT.
GOULD I. LT.
GULL ROCKS LT.
NEWPORT H'R LT.
LIME ROCK LT.
CASTLE HILL LT.
BRENTON REEF LT. VESSEL
SAKONNET LT.
HOG I. SHOAL LT.
STONINGTON BR'KW.
NEW HAVEN
BARTLETT REEF
WHALE ROCK



THIRD L. H. I
STRATFORD PT. LT.
BLACK ROCK LT.
PENFIELD REEF LT.
NORWALK ISLANDS LT.
STAMFORD H'R LT.
GREAT CAPTAIN I. LT.
THROGS NECK LT.
CORNFIELD
HORTON
STRATFORD SHOAL (MIDDLE GROUND)
OLD FIELD PT. LT.
EATONS NECK LT.
LLOYD H'R LT.
COLD SPRING H'R LT.
EXECUTION ROCKS LT.
SANDS PT. LT.
STEPPING STONES
FIRE ISLAND LT.
THE WORLD LT.
SANDY HOOK LT.
SCOTLAND
LT. VESSEL, NO 49
VESSEL
NO 7
TARRYTOWN LT.
River
74°
73°

Third District.

155. Gould Island, on east side of Gould Island, Rhode Island.—A boathouse, boat cradle, and boatways were built, and various repairs were made.

156. Conanicut Island, Narragansett Bay, Rhode Island.—A breakwater was built to protect the shore line of the reservation, and the space between the breakwater and the bank filled in with stone.

157. Wickford Harbor, on Old Gay Rock, Rhode Island.—Some 600 tons of riprap stone were placed to properly protect the pier. Various repairs were made.

158. Prudence Island, on Sand Point, east side of Prudence Island, Rhode Island.—The elevated walk between the dwelling and the tower was rebuilt, and various repairs were made.

160. Muscle Bed Shoals, on southeast side of the channel, opposite to Bristol Ferry Light, Rhode Island.—The boat landings were cleared of large stone; 112½ tons of riprap stone were placed around the pier, and various repairs were made.

162. Warwick, on southern extremity of Warwick Neck, Rhode Island.—The following recommendation, which was made in the Board's last four annual reports, is renewed:

A fog signal, in duplicate, is needed here. It can be established at an estimated cost of $5,000. It is recommended that an appropriation of this amount be made therefor.

165. Bullock Point, at the point of the shoal off Bullock Point, Providence River, Rhode Island.—Some 112½ tons of riprap were placed, and various repairs were made.

171. Point Judith, entrance to Narragansett Bay, Rhode Island.—A new steam pump was connected with the fog-signal boiler and new steam fittings were furnished.

176. Watch Hill, on Watch Hill Point, Rhode Island.—A portion of the east sea wall was rebuilt, and the remainder of the sea wall on the east, south, and west sides was thoroughly repaired. Various minor repairs were made.

177. Montauk Point, on the extreme east end of Long Island, New York.—A cistern was built below the basement of the dwelling. Various repairs were made.

179. Latimer Reef, on Latimer Reef, Fishers Island Sound, New York.—A coal bin was built; the concrete deck of the pier was repaired, and 275 tons of riprap were placed. Various minor repairs were made.

182. North Dumpling, on southwest side of North Dumpling Island, Fishers Island Sound, New York.—A boathouse was built. Various repairs were made.

—. Black Ledge, New London Harbor, Long Island Sound, Connecticut.—A survey of a portion of the ledge was made with a view of locating the site of the proposed light-house. The following recommendation, which was made in the Board's last four annual reports, is renewed:

Third District.

The necessity for establishing a light and an efficient fog signal in such a position as to enable vessels to enter and leave the harbor of New London, Conn., has become evident, and especially so for the aid of those approaching from seaward.

The numerous outlying shoals and ledges surrounding the entrance to this harbor make the approach to it dangerous in thick weather. The location of the present New London light and fog-signal station is so far inside the obstructions as to be partially ineffective as an aid for the purpose of safe navigation of this entrance. The commerce of the port of New London has so increased since the erection of the present light as to change the conditions materially. In consequence of the recent grounding of the steamer *City of Worcester*, on Bartlett Reef, complaint was made that the fog bell of Bartlett Reef light-ship was not adequate to the needs of vessels approaching New London from the westward in a fog, and it was stated that Congress would be petitioned to replace the present light-ship with another carrying a steam fog signal. In view of these facts and the further fact that a naval station is in operation on the Thames River, which empties into New London Harbor, it is suggested that a light and fog-signal station be established on the southwest ledge on the eastern side of the entrance to New London Harbor. Estimate is made that it can be done for $45,000. It is therefore recommended that an appropriation of that amount be made therefor.

203. Race Rock, off Race Point, Long Island Sound, New York.—A davit was erected on the landing wharf. Various repairs were made.

204. Little Gull Island, entrance to Long Island Sound, New York.—The portion of the landing wharf destroyed during the winter of 1892–'93 was rebuilt. Various repairs were made.

205. Gardiners Island, Long Island Sound, New York.—A new boathouse and boatways were built, and some other minor repairs were made. This station was abandoned March 8, 1894, on account of the encroachment of the sea. A gas-lighted buoy was, on May 31, 1894, moored in about 72 feet of water about a quarter of a mile N. by E. from Gardiners Island discontinued light-house. The buoy is painted black, lettered "G I" in white, and shows a fixed white light.

207. Long Beach Bar, Gardiners Bay, Long Island Sound, New York.—A crib landing wharf, filled with stone, and resting on large cut stone at low-water line, and a plank deck fitted with iron crane for hoisting the boat, connected with the gallery of the light-house by steps, were built.

208. Cedar Island, entrance to Sag Harbor, Long Island Sound, Long Island, New York.—A set of boatways were built.

247. Southwest Ledge, entrance to New Haven Harbor, Connecticut.—The following statement was made in the Board's last annual report:

> The establishment of a steam fog signal at Southwest Ledge light-station, at a cost not to exceed $12,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

The Board has revised its plans, and now proposes to install a Daboll trumpet here to be worked by petroleum engines in duplicate, which can be done at a cost not to exceed $3,000. Recommendation is made that an appropriation of this amount be made therefor.

The gallery was extended, and platforms, one on the northeast and one on the southwest angles, built to receive two boat winches. Various repairs were made.

Third District.

248. New Haven Long Wharf, New Haven, Long Island Sound, Connecticut.—A wooden railing was built around the base of the tower.

250. Stratford Shoal (Middle Ground), Long Island Sound, New York.—A new lens was supplied the station, caloric engines were overhauled and repaired, and the stone removed from the boat landing. Minor repairs were made.

252. Bridgeport Harbor, Long Island Sound, Connecticut.—The breakwater around the light-station was raised and extended 50 feet on the northwest side. A new Gamewell fog-bell apparatus was installed. Various repairs were made.

253. Bridgeport Breakwater, Long Island Sound, Connecticut.—A lantern light was established on the east end of the inner breakwater.

The following statement made in the Board's last annual report is repeated:

An appropriation of $2,000 was made by the act approved February 15, 1893, to establish a beacon light on the breakwater at Bridgeport. It was then supposed that the breakwater would serve as a foundation. This, as it now appears, is impracticable. A special foundation will have to be built for the beacon. It is estimated that it will cost $2,500.

NOTE.—An additional appropriation of $2,500 was made in the sundry civil appropriation act approved August 18, 1894, to build the foundation for this beacon. The work will be taken in hand at an early day.

260. Stamford Harbor, Long Island Sound, Connecticut.—An oil house was built, and minor repairs were made.

—. Pine Island, Stamford Harbor, Long Island Sound, Connecticut.—Pine Island is a small, rocky islet, about an acre in extent, covered with large bowlders, rocks, and a few trees. It lies on the east side of the estuary of Long Island Sound, which forms Stamford Harbor, the general direction of which is north and south. On the south side of this island the main estuary bifurcates, forming the East and West channels. The approach to this island from the outer light of Stamford, lying in the sound, passes through a narrow and crooked reach among shoals and rocks. A light on Pine Island would fully define the proper approach. The manufacturing interests of Stamford are quite large. Most of the coal consumed, as well as all heavy freights, are brought to this port by water instead of by rail. The arrivals by day and by night average four daily, and are increasing. The Federal Government is at present dredging out the East Channel, and a small light would also accentuate that entrance. The Board proposes to erect temporarily an iron spindle here and display from it a red lantern as a beacon. The site is used by the written consent of its owners. The cost of the establishment of the light is to be paid from the general appropriation for repairs, which provides for the establishment of such beacons.

262. Execution Rocks, Long Island Sound, New York.—As the dwelling

Third District.

had settled dangerously, the southwest wall was taken down, the loose stone upon which it rested was taken out and replaced, the voids were filled with concrete, and the wall was rebuilt. Various repairs were made.

264. Stepping Stones, near Hart Island, Long Island Sound, New York.—Contract was made for delivering and placing 300 tons of riprap stone for the protection of the pier.

269. North Brother Island, East River, New York.—A new lens with occulting clock was installed. A new bell tower and Gamewell fog-bell apparatus was set up. Various repairs were made.

275. Shinnecock Bay, Long Island, Atlantic Ocean, New York.—A picket fence was built inclosing the yard in front of the keeper's dwelling. Various repairs were made.

276. Fire Island, New York.—This is the most important light for transatlantic steamers bound for New York. It is generally the first one they make and from which they lay their course. It is a first-order light, flashing white at intervals of one minute. The illuminant is an oil lamp of 500-candlepower, and the intensity of the flash equals 63,830 candles. Mr. Henry Lepaute, of Paris, France, a manufacturer of lens apparatus for light-houses, exhibited at the World's Columbian Exhibition, held at Chicago in 1893, what is known as a bivalve lightning light, with electricity as an illuminant. It is called bivalve because it consists of two powerful range lenses, 9 feet in diameter, back to back, and is named a lightning light on account of the brilliancy and short duration of the flash. The arc light used is of very high candle power, and the makers claim that the intensity of the flash will be proportionately greater. The apparatus is so arranged as to give a flash every five seconds. The duration of the flash is about one-tenth of a second. The Light-House Board concluded to purchase this apparatus and install it in Fire Island light tower in place of the present lens. This necessitated in addition a steam and electric-light plant and a boiler and engine house to contain them. The steam and electric-light plant has been delivered by the makers at the Staten Island general depot. The boiler and engine house is now being built. During the change the light will be shown temporarily from a fourth-order lens.

288. South Beacon, Sandy Hook, New Jersey.—As the encroaching sea had endangered the foundations, the tower was moved 60 feet on the range toward the old light. Various repairs were made.

293. Conover front beacon, south shore of Sandy Hook Bay, New Jersey.—Wire fence was built near the high-water line and 162 feet of plank drain was built through the light-house reservation. Various repairs were made.

296. Waackaack, New York Bay, New Jersey.—The iron skeleton light-house tower was erected and the ironwork necessary to change the lantern to receive the apparatus is now in hand.

Third District.

300. Princess Bay, on Staten Island, New York.—Some 350 feet of picket fence was built. The bridge over the inlet to the swamp was raised, repaired, and extended 21 feet. Various repairs were made.

307. Fort Tompkins, on Staten Island, New York.—The following recommendation, made in the Board's last two annual reports, is renewed:

The light at Fort Tomkins at present is well back of the point it is intended to mark. It is therefore proposed to remove it from there to an angle of the stone fort at Fort Wadsworth, where it will better serve as a mark to the channel leading directly into New York Harbor. A fog signal at Fort Wadsworth would be of especial service to the large commerce going through the Narrows during thick weather. The fog bell at Fort Lafayette is serviceable to vessels bound to Coney Island, but it is too distant to be of much use to vessels using the other and more-frequented side of the channel. The change will make it necessary to build a lantern and watch room on the salient of the fort and to place a fog-signal house and apparatus at the foot of the wall. It is estimated that these changes can be made for not exceeding $1,500, and it is recommended that an appropriation of this amount be made therefor.

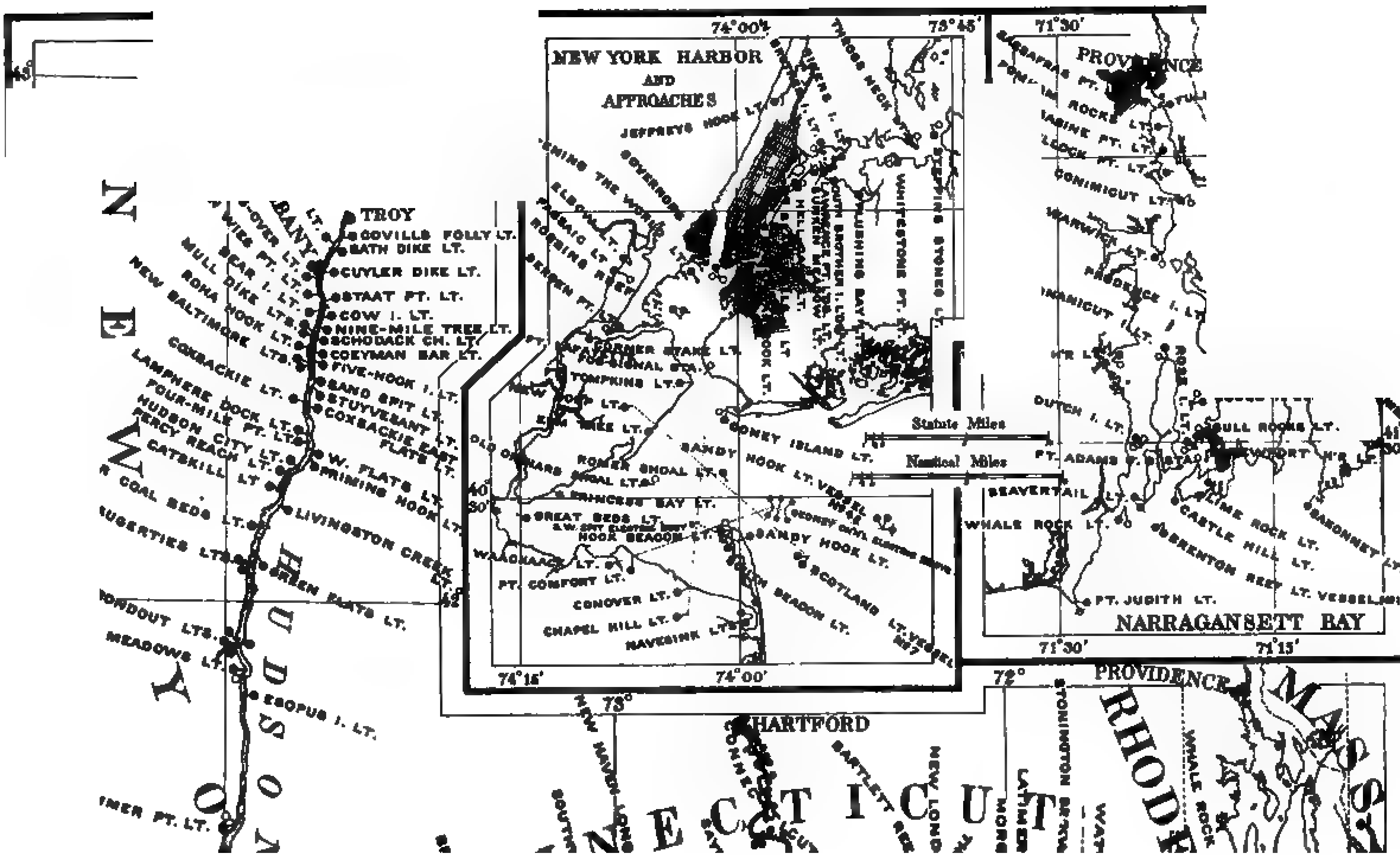
Various repairs were made.

310. Governors Island post light, northwest end of Governors Island, New York.—A Gamewell fog-bell apparatus was substituted for the worn-out Stevens apparatus.

316. Tarrytown, east side of Hudson River, New York.—Some 600 tons of riprap were placed to protect the pier.

317. Rockland Lake, Hudson River, New York.—An appropriation of $35,000 was made by the sundry civil appropriation act, approved on March 3, 1893, for establishing a light and fog signal at this place. Soundings were made in July, 1893. Plans and specifications were prepared. A contract was made for metal work and another was made for its erection. The foundation was strengthened by driving 66 piles 60 feet below low water in concentric rows. The outside circle of piles, 25 feet in diameter, supports the weight of the iron caisson. The heads of the inside rows of piles are embedded in the concrete filling of the cylinder. As soon as the piles were driven the erection of the caisson was begun. The metal work was delivered for the foundation on May 1, 1894, and two courses of the caisson were sunk on May 26, 1894, without accident. By June 30, 1894, the lower part of the tower was completed and ready to receive the superstructure. The contract requires that the station be completed December 1, 1894, but it will probably be finished in time to have it lighted by October 1, 1894. The following is from the technical description of the light-house:

The foundation of the tower is an iron caisson, rising 17 feet above mean sea level. The focal plane of the light is 37 feet above the base of the tower and 54 feet above mean sea level. The conical iron tower is placed on a black cylindrical base. Its lower half is brown, its upper half white, while the lantern is black. The lens is of the fourth order, and illuminates an arc of 360°. It shows an occulting light, 5 seconds fixed white light followed by an eclipse of 5 seconds. The tower is situated on the northern edge of the dredged channel to the pier of the ice company. There is 12 feet of water close to the light.



NEW YORK HARBOR AND APPROACHES
NARRAGANSETT BAY
Statute Miles
Nautical Miles
TROY
COVILLS FOLLY LT.
BATH DIKE LT.
CUYLER DIKE LT.
STAAT PT. LT.
COW I. LT.
NINE-MILE TREE LT.
SCHODACK CH. LT.
COEYMAN BAR LT.
FIVE-HOOK I. LT.
SAND SPIT LT.
STUYVESANT LT.
COXSACKIE EAST FLATS LT.
W. FLATS LT.
PRIMING HOOK LT.
LIVINGSTON CREEK LT.
GREEN FLATS LT.
ESOPUS I. LT.
MULL DIKE LTS.
ROHA HOOK LTS.
NEW BALTIMORE LTS.
COXSACKIE LT.
LAMPHERE DOCK LT.
FOUR-MILE PT. LT.
HUDSON CITY LT.
PERCY REACH LT.
CATSKILL LT.
COAL BEDS LT.
MEADOWS LT.
HUDSON
NEW YORK
JEFFREYS HOOK LT.
ELBOW LT.
PASSAIC LT.
ROBBINS REEF
BERGEN PT.
CORNER STAKE LT.
FOG SIGNAL STA.
TOMPKINS LT.
OLD ORCHARD SHOAL LT.
ROMER SHOAL LT.
PRINCESS BAY LT.
GREAT BEDS LT.
HOOK BEACON LT.
PT. COMFORT LT.
CONOVER LT.
CHAPEL HILL LT.
NAVESINK LT.
SANDY HOOK LT.
SCOTLAND LT. VESSEL
SANDY HOOK LT. VESSEL
CONEY ISLAND LT.
WHITESTONE PT. LT.
STEPPING STONES LT.
THROGS NECK
PROVIDENCE
SASSAFRAS PT.
POMHAM ROCKS LT.
SABINE PT. LT.
BULLOCK PT. LT.
CONIMICUT LT.
WARWICK LT.
PRUDENCE I. LT.
DUTCH I. LT.
PT. ADAMS
BEAVERTAIL LT.
WHALE ROCK LT.
PT. JUDITH LT.
BULL ROCKS LT.
NEWPORT
CASTLE HILL LT.
LIME ROCK LT.
BRENTON REEF LT. VESSEL
SAKONNET LT.
HARTFORD
CONNECTICUT
NEW HAVEN
BARTLETT REEF
NEW LONDON
STONINGTON BRKWATER
LATIMER
RHODE
MASS.
WHALE ROCK
74°00'
73°45'
71°30'
71°15'
74°15'
73°
72°

Third District.

202. Bartlett Reef light-vessel, No. 13, off New London, Long Island Sound, Connecticut.—This vessel was taken off her station on May 1, 1894, and is at present undergoing repairs. The oil room between decks was moved aft, new masts and wire rigging were put in, her day marks are being refastened, her planking and metal will receive attention, and she will be cleaned and painted throughout. She received during the year ship chandlery, medicines, provisions, and fuel.

244. Cornfield Point light-vessel, No. 51, off the mouth of the Connecticut River, Long Island Sound, Connecticut.—This vessel, with her electric light, steam fog signal and all modern improvements, continues to give to the navigators of Long Island Sound the confidence and satisfaction which her equipment and position were designed to create. The vessel was taken off her station for repairs October 20, 1893, and returned thereto on November 1 following. She received during the year ship chandlery, gaskets, grate bars, brushes, canvas, lime, and fuel.

277. Sandy Hook light-vessel, No. 48, off the entrance to New York Harbor, New York.—This vessel shows two red lights, one of them a flashing light, and operates a steam chime whistle for a fog signal. She received during the year paints, oars, hose, lumber, grates, blocks, engineers' stores, ship chandlery, lime, and fuel.

278. Scotland light-vessel, No. 7, off Sandy Hook, entrance to New York Bay, New York.—The Board is making experiments with a view to laying a telephone cable between this light-ship and Sandy Hook, and in order to have the receiving circuit properly adjusted on board she will be brought in to the general light-house depot. She received during the year lumber, ship chandlery, stove, provisions, and fuel.

—. *Relief light-vessel, No. 20.*—On May 1, 1894, this vessel was placed on the Bartlett Reef station as the relief of No. 13, taken off for repairs. Since she was placed she has had both her boats stove in and her stem twisted by being run into by three sailing vessels. She is in need of considerable repair. When she is taken off the station she will have to be docked and repaired. She is kept at the New London light-house depot, always ready for service at short notice as a relief light-ship. She received during the year paints, stove fixtures, and ship chandlery.

—. *Relief light-vessel, No. 23.*—This vessel is at the light-house depot, New London, Conn. She is held in readiness for service. During the year she acted as the relief of No. 51, on Cornfield Point, from October 20 to November 1, 1893. She received during the year paints, rope, and the like.

—. *Relief light-vessel, No. 16.*—This vessel is kept at the general light-house depot, Staten Island, New York. Being equipped with apparatus for a flashing light and with fog-signal machinery, she is held in readiness not only for the special service of relieving Sandy Hook light-ship, No. 48, but for similar duty elsewhere. The vessel received during the year flags, lumber, rope, and paints.

Third District.

DAY OR UNLIGHTED BEACONS.

All the day beacons in the district were painted during the year.

Rose Island, south, Narragansett Bay, Rhode Island.—A spindle. The spindle was bent over by the steamer *Plymouth,* and will be repaired.

Halfway Rock, Narragansett Bay, Rhode Island.—A spindle and square cage. The cagework was carried away, and will be replaced as soon as practicable.

Goat Island Shoal Dolphin, Newport Harbor, Rhode Island.—A clump of five piles. An incandescent electric light is maintained on this beacon by the Old Colony Steamboat Company.

Warwick or Spindle Rock beacon, entrance to Greenwich Bay, Rhode Island.—An iron spindle, with square wooden cage. The cage was carried away, and will be replaced.

Pomham beacon, Providence River, Rhode Island.—A stone tower, surmounted by a black ball. The ball is broken, and will soon be repaired.

Castle Island beacon, Bristol Harbor, Rhode Island.—A stone tower, surmounted by a red ball. The ball was carried away; it will soon be replaced.

East spindle, Fishers Island Sound.—An iron spindle, with a cask. The spindle needs to be straightened. This will soon be done and a new cage will be added.

Wicopesset Rock, Lords Passage, Fishers Island Sound.—An iron spindle with a cask. Both need repair.

Potter (or Seaflower) Reef beacon, Fishers Island Sound.—A square granite structure, surmounted by an iron spindle and cage. The base is open and needs a protection of riprap stone. It will be repaired, and a new cage will be added at an early day.

Oyster Pond Reef, on the eastern rock, off Orient Point, Long Island, New York.—A cast-iron cylinder, filled in with concrete, surmounted by an iron shaft and square cage. Riprap was placed around the base of the cylinder to protect it against the ice.

Sand Spit, Sag Harbor, New York.—An iron cylinder, surmounted by a spindle and square cage. This beacon, which was thrown down by ice, was set up and some 112 tons of riprap were placed around it for its protection.

Stratford beacon, Connecticut.—A spindle (wooden), surmounted by a cask, has been set up.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

147. Beavertail, Rhode Island.—The 10-inch steam whistle, with Crosby automatic signal, was in operation about 574 hours during the year, and consumed some 55 tons of coal.

Third District.

171. Point Judith, Rhode Island.—The first-class steam siren, in duplicate, was in operation about 904 hours, and consumed some 56 tons of coal.

175. Block Island (southeasterly), Rhode Island.—The first-class steam siren, in duplicate, was in operation about 810 hours, and consumed some 50 tons of coal.

177. Montauk Point, New York.—The first-class Daboll trumpet, worked by caloric engines, in duplicate, was in operation about 575 hours, and consumed some 5 tons of coal.

183. New London Harbor, Connecticut.—The first-class Daboll trumpet, in duplicate, was in operation about 610 hours during the year, and consumed some 8 tons of coal.

204. Little Gull Island, New York.—The second-class steam siren, in duplicate, was in operation about 618 hours during the year, and consumed some 35 tons of coal.

244. Cornfield Point light-vessel, Connecticut.—The 12-inch steam whistle was in operation about 632 hours, and consumed some 112 tons of coal.

246. Falkner Island, Connecticut.—The 10-inch steam whistle, in duplicate, was in operation about 485 hours during the year, and consumed some 38 tons of coal.

250. Stratford Shoal (Middle Ground), New York.—The second-class Daboll trumpet was in operation about 498 hours, and consumed some 8 tons of coal.

255. Penfield Reef, Connecticut.—The Daboll trumpet, in duplicate, was in operation 404 hours, and consumed some 3 tons of coal.

257. Eatons Neck, New York.—The second-class steam siren, in duplicate, was in operation about 611 hours during the year, and consumed some 44 tons of coal.

261. Great Captain Island, New York.—The 10-inch steam whistle, Crosby automatic, in duplicate, was in operation 373 hours, and consumed some 30 tons of coal.

262. Execution Rocks, New York.—The first-class automatic steam siren, in duplicate, was in operation 319 hours during the year, and consumed some 45 tons of coal.

277. Sandy Hook light-vessel, New York.—The 12-inch steam chime whistle was in operation about 715 hours during the year, and consumed some 94 tons of coal.

289. Hook Beacon, Sandy Hook, New Jersey.—The first-class automatic steam siren, in duplicate, was in operation about 686 hours during the year, and consumed some 80 tons of coal.

308. Robbins Reef, New York Harbor.—The blower siren was in operation about 267 hours during the year, and consumed some 4 tons of coal.

Third District.

BUOYAGE.

The weather of the past winter was mild, with the exception of short periods of heavy frost. The number of buoys carried off or displaced by ice was, therefore, comparatively small. The tenders rendered service to the Navy by placing buoys to mark the courses for the trial of the new ships *Montgomery* and *Marblehead.* Six ordinary buoys were discontinued during the year, and 16 new ones were added to the list. Gas buoys were placed at Gardiners Island, New York, and at Little Captain Island and Jones Rocks, Connecticut, and a bell buoy at Sarah Ledge, New London Harbor, Connecticut.

281–286, 291. Gedney Channel electric buoy station, entrance to New York Bay.—There were short spells of very severe weather, but on the whole the weather during the past winter was mild. The system, therefore, was not subjected to any unusual strain by the flow of ice, nor was the plant appreciably injured by the action of wind and sea. There were heavy gales during the year, however, causing such defects in the cables that some of the lights were extinguished for several days at a time. Owing to all causes, some of the lights were out at one time or another on 276 nights during the year. The principal damage sustained was caused by the steamer *Gedney*, employed by the United States engineers to dredge out the channels of the Lower Bay. She fouled the triple-conductor cable, broke it in parts, and strained it all over. In consequence of this accident, all the red lights were out from April 18 to May 14, when new cable was laid from near the beach out to the junction box, and lighting up was resumed. In this important service the Western Union Telegraph Company placed its steamer *Western Union* at the disposal of the inspector, and for its aid and skill, promptly and courteously rendered, was thanked by the Light-House Board. To repair the damage to the cables, caused by wear and tear and accident, there was an expenditure of 1,350 feet of triple-conductor cable and 250 feet of single-conductor cable. Many lamps were broken during storms and by passing vessels striking the buoys. The replacing of these, splicing the cables, and various other repairs incidental to the maintenance of the lights, were promptly and efficiently done by the tenders *John Rodgers* and *Gardenia*, assisted, whenever practicable, by the keepers and the steam launch of the lighted-buoy station at Sandy Hook. The work was done under the general supervision of Lieut. Commander C. H. West, U. S. Navy, assistant to the inspector, whose report, in detail, of the history and operations of the plant and system is given in an appendix to this report.

During the early spring it was necessary to take up the cable running from the power house at Sandy Hook to the red lights in Gedney Channel on account of the cable having been fouled and injured by one of the dredges employed by the engineer for the river and harbor improve-

ment. This cable was found to be cut in a number of places, and kinked up so badly as to make its repair most difficult and almost impossible. After all kinks had been removed and the cable respliced it was found that only enough had been saved to answer for limited repairs to the cables now in position. The present system employed at Sandy Hook is the result of experience, after experiments made a number of years ago, when the application of subaqueous lighting was in its infancy and before more refined and less expensive methods were known. The experience gained with the cable laid on the water front at Chicago, and studies for placing a similar system elsewhere, opened up wide inquiry and further experiment, with the result that it is now found that less expensive cables, with the alternating electric current, can be used at Sandy Hook. The employment of a three-conductor cable with double armor means great expense in renewing and relaying and much complication in repairing, while the low voltage of the system gives inferior and uncertain lights. With a single conductor, hard copper armor, using the alternating current, gives the advantage of high voltage, which can be transformed down to the required voltage at the lamp. Using the conductor for transmitting the high current to the lamp, and the armor to return the current to the dynamo, gives the advantage of a single cable from the station to the buoys in channel and enables crossing at the outer or seaward buoys; then back on the north buoys, where it would end, the return following the same circuit back on the armor to the machine. This cable can be made cheaper, will be much more enduring, and much more efficient in lighting this channel. It will give greater extension to this system of lighting, and will reduce the expense of maintenance greatly. It is proposed to increase the number of lighted buoys from 6, at present, to 10, and to cover a channel way of about 8,000 feet, instead of 4,000, while the new dynamos, new cable, and entirely new installation will not much exceed the cost of one three-conductor, double-armored cable needed for the white or red lights of the Gedney Channel. Before removing the old system it is proposed to install the new, and to work it for at least one month before removing the old cables and buoys.

A new 25-horse power Fitzgibbon boiler was furnished in October, and an extension to the power house was made for its reception. The other boilers and the entire machinery were overhauled and received extensive repairs and renovations during the year, and the station, in general, is now in good order.

DEPOTS.

Staten Island, New York.—This depot is the purchasing, receiving, storing, and distributing center for the general supplies required by the entire Light-House Establishment. The operations carried on here are on a large scale, performed by a comparatively small force of men.

Third District.

These are so thoroughly trained and so well stationed that their number is supplemented by their skill. The entire force at the depot, including the crews of the tenders when on hand, is organized as a fire department, so thoroughly drilled and equipped that within a few minutes from the ringing of the bell the several lines of hose are playing on the location of the supposed fire. An entire outfit of electric apparatus, including a Fitzgibbon boiler, was procured and installed in a part of the engine house of the yard, and the depot is now lighted by its own electric plant. The advantages thus secured are, independence of the exigencies of outside supply, better light furnished with a large saving in expense, and the safety of the buildings and supplies increased by a system under the inspector's control.

Under the directions of the inspector the operations at this depot during the year ending June 30, 1894, included the receiving and testing of oils, paints, chimneys, etc.; inspecting and weighing rations for light-stations and tenders in the Third district and stores of various kinds for the general Light-House Service; making and repairing awnings, tarpaulins, and boat sails; repairing, cleaning, and painting buoys; overhauling and repairing tenders; making and repairing boats for light-stations and tenders; receiving and storing, packing and shipping supplies, buoys, appendages, buoy chain, chain, anchors, and other fitments for light-vessels, fuel, and rations; loading and unloading the supply steamer and tenders. Various minor repairs were made to the interior of the storehouse for supplies, new shelving and closets were put up, and the woodwork was repainted. The interior of the laboratory was repainted and recalcimined. The carpenter and boat shop was repaired and enlarged to accommodate the increasing amount of work required of the carpenters and boat builders. The shop is now in good order and well adapted for the objects intended.

Much was done during the year toward systematizing and improving the facilities for the transportation of the large and growing business connected with the depot. The work of the office and depot was carefully and efficiently done. A new system of keeping and rendering accounts was devised and tentatively adopted. It is proposed to increase the functions of the general depot as a center for the reception, storage, and distribution of all supplies which, considering the questions of cost, quality, and transportation to the various districts of the Establishment, can be best procured here; to keep distinct the accounts of the general depot and the Third light-house district, to secure a proportionate allotment of the general appropriations, and to afford to the Board a constant supervision of the expenditure of its funds. The new system will be conformed to as far as practicable during the current fiscal year, and at the close of the latter it will, as amended by experience, be finally adopted.

Third District.

Depot electric plant.—On June 28, 1894, the electric plant of the yard was ready for operation. Experimental trials proved it quite equal to the work required, while the light yielded was much superior to that formerly drawn from the city electric company. The wiring of all buildings being in accordance with the latest underwriter's requirements, increased safety to the quarters and buildings has resulted. The plant is operated at present by three laborers, who have been taught enough of practical electricity to handle the dynamos and to operate the machinery.

The work done at the general depot by the light-house engineer consists of making and repairing lamps, fitting illuminating apparatus, making oil cans and boxes for supplying oil to light-stations, making light-house and light-ship lanterns, fog signals and their appurtenances, receiving material for manufacturing and repair work, repairing light-houses, oil houses, and other structures, repairing buoys and appendages, and general works of repair in the district. In addition, certain experiments relating to new and improved methods of lighting and to improvements in fog signals were intrusted to and are being carried out by him.

Sea wall.—The cofferdam was completed in November. During December, 1893, some progress was made in pumping out the mud. By March 31 nearly one-half of the concrete had been placed, a portion of which was brought up to 5½ feet below low water, and about seven-eighths of the mud had been removed from the whole cofferdam. The time (February 15) for the fulfillment of the contract having expired, an extension of two months was granted. During April the cofferdam and concrete were badly damaged by a heavy storm, causing much delay and expense in making repairs. Another extension was asked for and granted to June 30. When damages had been repaired and the work was progressing favorably, in May another storm, lasting four days, damaged the cofferdam to such an extent as to require the rebuilding of about half of the outer face, and the concrete benched down for a length of 70 feet to make proper bed to receive additional concrete required to bring it up to the 5½-foot level below low water. On June 30 the concrete had all been placed and one-third of the stone superstructure laid for a distance of 40 feet in the south end up to the coping course.

Plans and specifications were prepared for furnishing metal work for the new south wharf. On January 26, 1894, a contract was made to furnish and deliver the metal at this depot, to be completed May 3. An extension was asked for and granted, extending the time fifteen days, and it was finally completed May 29, 1894.

NOTE.—An appropriation of $25,000 was made by the sundry civil appropriation act, approved on August 18, 1894, for continuing the sea wall, rebuilding the south wharf, and dredging the basin.

Third District.

The following is a list of the improvements needed at this depot, with their estimated cost. They are arranged in the order of their necessity.

WHARVES AND BASIN.

South sea wall	$50,000
South wharf	15,000
Dredging basin and removing old wharves	15,000
Bulkhead and filling	40,000
Coal wharf	5,000
Extension to lamp shop	24,000
New elevator	3,000
New boiler room	2,500
New engine, in place	3,000
New boiler, in place	2,000
Additional shafting	500

ADDITIONAL BUILDINGS.

Coal shed	5,000
Hoisting machinery	1,000
New oil house	20,000
Engineer's storehouse	3,000
Extending blacksmith shop	1,500

It is estimated that improvements to the extent of $100,000 are urgently needed during the coming year, and it is recommended that an appropriation of at least this amount be made therefor.

New London, Conn.—Two relief ships, No. 20 for general service and No. 23 specially for duty at Cornfield Point, where there is an electric light and a fog signal, are kept at this depot. The tender *Cactus* is stationed here, her work being chiefly confined to the eastern section of the district. For her use and distribution there is kept here a stock of oil, lime, cleansing materials, buoys and appendages, chain cable, anchors, and fuel. The keeper of the depot is also keeper of the two relief ships, which latter are kept, as far as practicable, ready for service. A survey was made of the light-house reservation, including wharves, with a view of establishing the limit to the right of way of the railroad. The railroad company moved back the buildings on the buoy wharf to correspond with their presumptive right of way. Various repairs were made.

Goat Island, Newport Harbor, Rhode Island.—Buoys and appendages, light-ship chain, and anchors to meet emergencies are kept at this depot. There is also stored here a supply of coal for the stations in the vicinity, and for the tenders when working at that end of the district. The portable railroad for coal was repaired.

Juniper Island, Lake Champlain, Vermont.—This depot is used for the storage of buoys, boats, and supplies for the service on Lake Champlain. It is kept by the keepers of the light-station on the island and is in good order.

Third District.

TENDERS.

The Armeria.—This steamer was employed throughout the year in delivering supplies to the light-stations from St. Croix River, Maine, to Point Isabel, Texas, embracing three voyages in all. In performing this duty she steamed 15,000 miles and consumed 1,190 tons of coal. The supplies delivered consisted of 246,000 gallons of mineral oil, 300 tons of paints, oils, and turpentine, 4,000 boxes of chimneys and cleaning materials, and 12,000 packages of miscellaneous stores, an increase of cargo in all except the oil, which was a little less than the quantity delivered last year. In addition to the regular supplies she carried to the different district depots 1,300 packages, 350 tons of chains, sinkers, and ballast balls. The *Armeria* met very heavy weather during her trips in the fall and winter, which made it dangerous to cross the shoal-water bars and to land supplies for the seacoast lights. On the eastern coast the prevalence of fog rendered navigation difficult, but no accidents happened. These important services were done with accustomed diligence and skill. She is kept clean and in good order. During the year repairs were made to the main boilers. The electric light on board gave excellent service, and the search light was used with advantage when required. She received during the year new pumps and new water tanks.

The John Rodgers.—This steamer was constantly employed during the year, with the exception of 34 days when she was laid up to receive her new boiler. She steamed altogether about 8,625 miles, and consumed some 628 tons of coal. She changed or replaced 227 buoys, recovered and painted 252, made 62 shipments of freight for other districts, delivered 435 tons of coal, 10 cords of wood, and 139 lots of supplies, and inspected 123 stations. She was employed 63 days in repairing the cables and attending to the electric-lighted buoys at Sandy Hook, 12 days changing and filling the gas tanks at Romer Shoal beacon, and 39 days at the general depot preparing shipments, storing supplies, painting buoys, exercising at fire-drills, and rendering such assistance as was required in the general work of the yard and grounds. On the other working days of the year she was engaged in buoy service, delivering supplies, serving post lights, tours of inspection, and marking wrecks. Her work was well and carefully done, and she is kept neat and in good condition. The cylinder bottom was repaired temporarily by the engineers of the vessel, and will have to be removed at an early day. She received during the year a new boiler, and was cleaned and painted when laid up for repairs.

The Cactus.—This steamer was kept busy throughout the year, but 53 days were spent in making repairs, when she was hauled out on the ways and cleaned and painted. In the performance of her duty she steamed about 10,315 miles and consumed some 535 tons of coal. She

Third District.

changed and replaced 343 buoys, inspected 88 stations, delivered 49 lots of rations, 236 packages of extra supplies, 944 tons of coal, 39 cords of wood, and 28 barrels of lime. In addition, she painted 20 day beacons and all the buoys in the eastern section of the district. She took the Cornfield Point and Bartlett Reef light-vessels off station for repairs, and returned the former vessel when the work was done. She gave 15 days' service in placing and removing trial buoys for the Navy.

The Gardenia.—This steamer is a propeller, and renders special service in the shipment of freight to and from the various docks along the water fronts of the harbor of New York. During the past year she was actively employed in various duties, with the exception of 37 days, when she was laid up for repairs to her engine and boiler. She was hauled out on the railway; she received an iron shoe in place of the old wooden one, a new shaft, a new pump, and extensive repairs to her machinery, and was cleaned and painted throughout. This vessel placed or replaced 187 buoys, painted 197, and recovered 5 iron buoys from off the beach and 2 sunken bell buoys. She worked on the cables at Sandy Hook 12 days, changed electric-lighted buoys 9 times, and replaced their lamps 20 times. She delivered 558 tons of coal and 12 cords of wood, carried 29 shipments of freight to the different transportation lines, and made the regular tours of inspection. In performing this service she steamed about 7,074 miles, and consumed some 404 tons of coal. Her work was carefully done, and she is always kept in a creditable condition.

The Mistletoe.—This steamer was almost entirely engaged on works of repair. She is in fair condition as to her hull, but her boiler and engine need renewal. Continual repairs were made to make them safe to use. During the year she has run about 7,570 miles with a consumption of some 482 tons of coal.

The Rose.—The boiler and engine put in last year do not yet work satisfactorily. Breakdowns were frequent. Repairs and alterations have recently been made to the boiler, but it is too soon to say that they will be effective. During the year she ran 37 miles with a consumption of 50 tons of coal.

Launch Nettle.—A new boiler was put in this steam launch and a few smaller repairs were made. She was usefully employed in Lake Champlain, the Hudson River, and in carrying workmen and light freight about New York Bay and Harbor. During the year she ran about 2,995 miles with a consumption of some 54 tons of coal.

Tender for engineer of the Third light-house district.—The engineer's tender, the *Mistletoe*, is the oldest tender in this district, and one of the oldest in the service. She was built in 1871-'72. She has done good service, but to put her in effective condition would require new boilers, engine, shafting, wheels, and such other radical changes that it

Third District.

would be more economical to build a new boat of a stronger and more modern type.

With the hard and continuous service to which she is generally put to keep such a large district as this in proper repair, her boiler and machinery continue to deteriorate, and after nearly every long trip she has to be laid up for several days for imperative repairs. This is a loss not only of money but of valuable time and might be the cause of a very serious accident in case some important aid to navigation should be disabled on account of having no boat available to promptly put it in repair.

The following recommendation, made in the Board's last two annual reports, is renewed:

> A new steel screw steamer is needed to take the place of an old side-wheel steamer. The latter has been nearly worn-out by long and hard service in the waters of Long Island Sound and on the seacoast of New York. She is too small to do the work of the Third light-house district properly. She is so slow that a great deal of time is lost unnecessarily. The needs of this district, which is the largest and most important of the country, would be far better and more economically subserved by a steamer of the latest design. It is estimated that such a steamer can be built, fitted out, and made ready for service at a cost not exceeding $95,000, and it is recommended that an appropriation of this amount be made therefor.

It will cost between $35,000 and $40,000 to put the *Mistletoe* in good order. Should such an expenditure be made she will still be ill adapted to the work she has to do because she is a side-wheel vessel, and because she will never have the necessary speed.

The Bouquet.—The small steamer which was used in attending to the electric-lighted buoys in Gedney Channel, New York Lower Bay, was wrecked during a cyclone in the fall of 1893. It is estimated that it will cost not to exceed $4,000 to replace her. Recommendation is made that an appropriation of this amount be made therefor.

FOURTH DISTRICT.

The Fourth district extends from Shrewsbury River, New Jersey, to and including Metomkin Inlet, Virginia, and embraces all the aids to navigation on the seacoast of New Jersey below the Highlands of Navesink, on the Delaware Bay, the Delaware and Schuylkill rivers, the seacoasts of Delaware and Maryland, and part of the seacoast of Virginia.

Inspector.—Commander Purnell F. Harrington, U. S. Navy, to July 15, 1893; since then Commander George C. Reiter, U. S. Navy.

Engineer.—Capt. Frederick A. Mahan, Corps of Engineers, U. S. Army, to February 24, 1894; since then Maj. Charles W. Raymond, Corps of Engineers, U. S. Army.

In this district there are:

Light-houses and beacon lights, including 7 post lights	56
Light-ships in position	4
Day or unlighted beacons	5
Fog signals operated by steam or hot-air engines	6
Fog signals operated by clockwork	7
Lighted buoys in position (gas)	1
Whistling buoys in position	4
Bell buoys in position	6
Ice buoys for winter use	4
Other buoys in position	186
Steamer *Zizania*, buoy tender and for supply and inspection	1

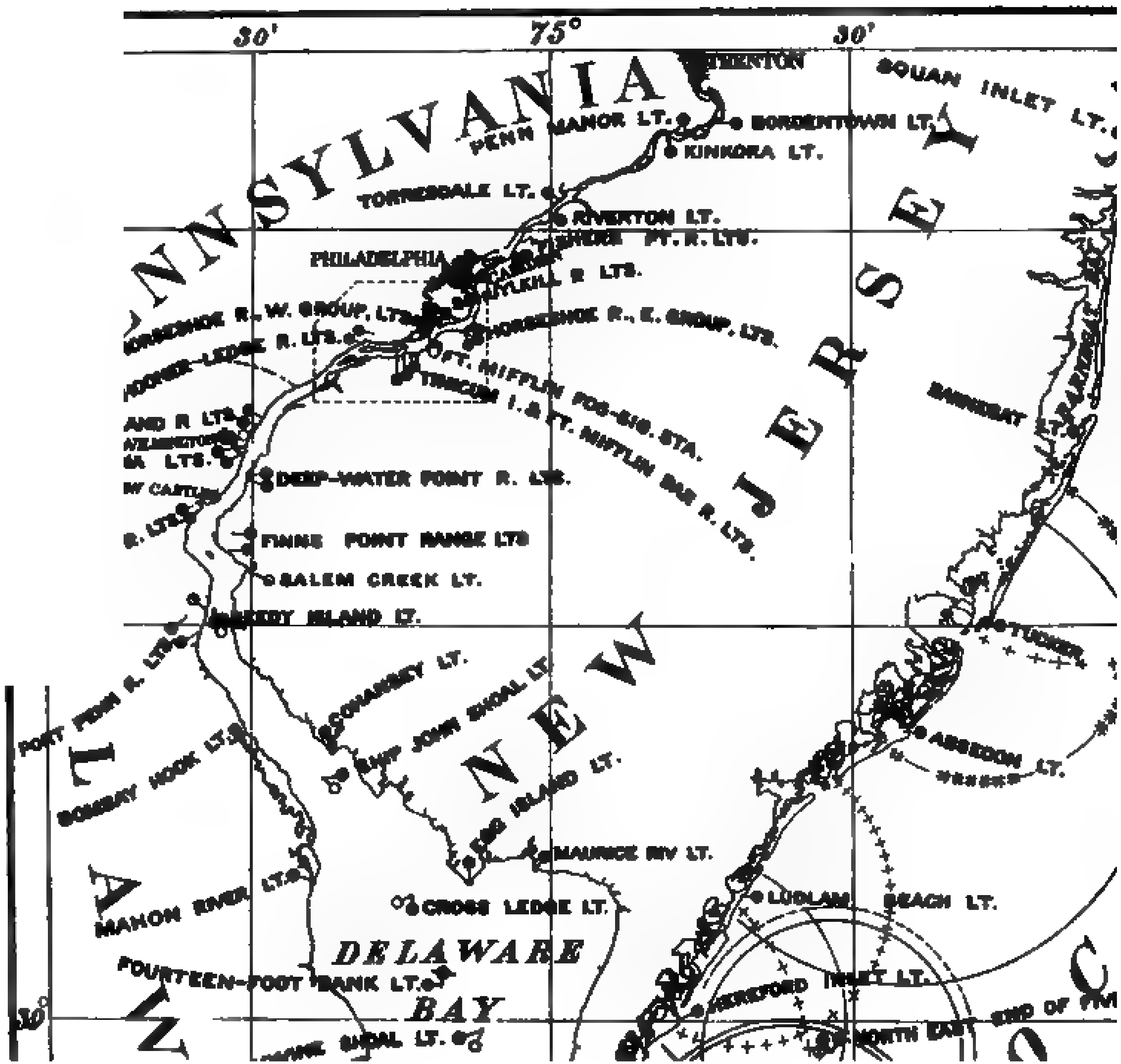
LIGHT-STATIONS.

363. Squan Inlet, seacoast of New Jersey.—The site was selected, but, owing to difficulties which have arisen in the way of procuring a clear title, the purchase has not been completed.

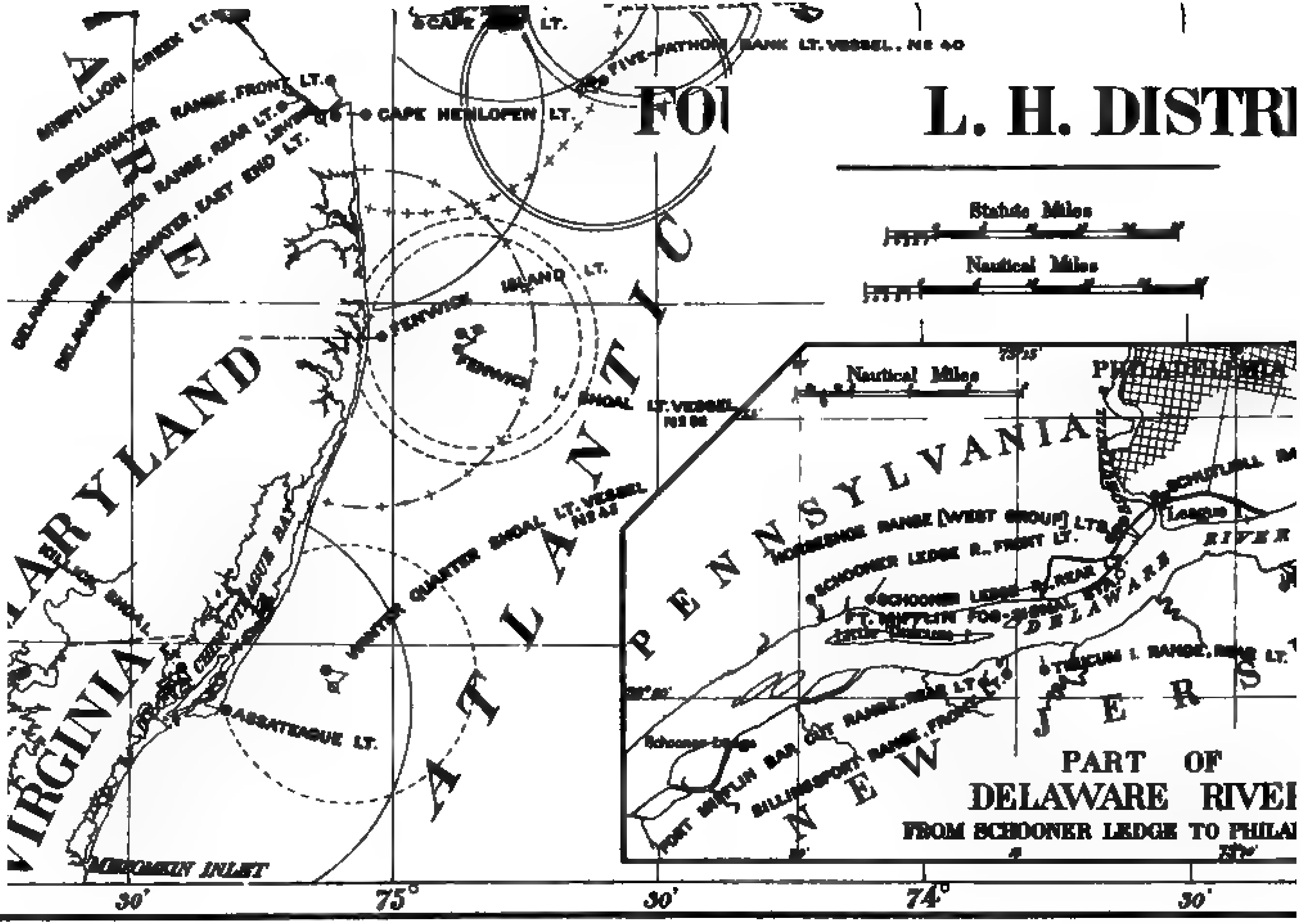
364. Barnegat, Barnegat Inlet, seacoast of New Jersey.—The alteration and remodeling of the keeper's dwelling, in progress at the close of the last fiscal year, were completed. A timber and brush bulkhead about 190 feet long, with three spurs of about 61 feet each in length, was constructed to protect the beach and reservation from the inroads of the sea.

365. Tucker Beach, entrance to Little Egg Harbor, seacoast of New Jersey.—The station was supplied with a new set of illuminating apparatus—lens, pedestal, revolving clock, and a set of Funck-Heap lamps.

367. Ludlam Beach, Sea Isle City, seacoast of New Jersey.—A small landing bridge was built from the sea wall to the outer row of piles protecting the beach.



30'
75°
30'
PENNSYLVANIA
NEW JERSEY
DELAWARE
DELAWARE BAY
TRENTON
SQUAN INLET LT.
PENN MANOR LT.
BORDENTOWN LT.
KINKORA LT.
TORRESDALE LT.
RIVERTON LT.
PHILADELPHIA
SCHUYLKILL R LTS.
FT. MIFFLIN FOG-SIG. STA.
TINICUM I. & FT. MIFFLIN BAR R. LTS.
BARNEGAT LT.
DEEP-WATER POINT R. LTS.
FINNS POINT RANGE LTS
SALEM CREEK LT.
REEDY ISLAND LT.
PORT PENN R. LTS.
BOMBAY HOOK LT.
COHANSEY LT.
SHIP JOHN SHOAL LT.
EGG ISLAND LT.
MAURICE RIV LT.
TUCKER
ABSECON LT.
MAHON RIVER LT.
CROSS LEDGE LT.
LUDLAM BEACH LT.
HEREFORD INLET LT.
FOURTEEN-FOOT BANK LT.
NORTH EAST END OF FIVE



L. H. DISTRI
FO
Statute Miles
Nautical Miles
CAPE HENLOPEN LT.
FIVE-FATHOM BANK LT. VESSEL, No 40
MISPILLION CREEK LT.
DELAWARE BREAKWATER RANGE, FRONT LT.
DELAWARE BREAKWATER RANGE, REAR LT.
DELAWARE BREAKWATER, EAST END LT.
FENWICK ISLAND LT.
FENWICK SHOAL LT. VESSEL
WINTER QUARTER SHOAL LT. VESSEL
ASSATEAGUE LT.
CHINCOTEAGUE BAY
MEGOMKIN INLET
MARYLAND
VIRGINIA
ATLANTIC
PENNSYLVANIA
NEW JERSEY
DELAWARE
RIVER
Nautical Miles
HORSESHOE RANGE (WEST GROUP) LTS.
SCHOONER LEDGE R., FRONT LT.
SCHOONER LEDGE R., REAR LT.
FT. MIFFLIN FOG-SIGNAL STA.
FORT MIFFLIN BAR CUT RANGE, REAR LT.
BILLINGSPORT RANGE, FRONT LT.
SCHUYLKILL
League
Schooner Ledge
PART OF
DELAWARE RIVE
FROM SCHOONER LEDGE TO PHILA
30'
75°
30'
74°
30'

Fourth District.

373. Delaware Breakwater, on the east end of the breakwater, Delaware Bay, Delaware.—The fog signal was refitted with two new Rider engines, and its characteristic was changed to blasts of 3 seconds with silent intervals of 27 seconds. Various repairs were made.

—. *Big Oyster Beds, mouth of Maurice River, Delaware Bay, New Jersey.*—The establishment of a light and fog signal here, at a cost not exceeding $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

—. *Maurice River range lights, Delaware Bay, New Jersey.*—It is claimed that some 500 sailing vessels are engaged in the oyster trade on Maurice River during the season, and that they give employment on an average to 1,500 men; in addition, a number of coasting vessels visit this river, and the establishment of manufactures at Millville, N. J., is increasing the marine traffic. The value of this commerce is sufficient to warrant the establishment of range lights to mark the entrance to Maurice River. It is estimated that the surveys and examinations, the sites, the erection of the range lights, and the keeper's quarters will cost not to exceed $4,500. Recommendation is made that an appropriation of this amount be made therefor.

381. Cross Ledge, Delaware Bay, New Jersey.—The riprap foundation upon which the stone pier which carries the light is built was seriously damaged and rendered unsafe by the gales and ice of the winter of 1892–'93, and an examination disclosed undermined sections of from 10 to 15 feet in length, 5 to 7 feet in width, and 3 to 5 feet in depth, and that nearly all of the heavy face stones covering the riprap had been carried away. The plan of repair carried out was to fill the voids with Portland cement concrete and to surface the riprap foundation with the same material from the base of the pier to low-water mark, a distance of 16 feet, the depth of the concrete being from 10 inches to 2 feet 6 inches above low-water mark and about the same depth below low-water mark. Much of the concrete below low water was laid in bags. As the work could be carried on only at extreme low water and at periods of almost dead calm, it was difficult and subject to frequent delays. Heavy blocks of riprap, weighing from about 2 to 6 tons, are being placed around the station at a distance of about 60 feet from the pier, two approaches to the light being left open. A new iron railing was placed around the light-house on the deck of the pier, new landing ladders were furnished, and various repairs were made.

382. Mahon River, at mouth of Mahon River, Delaware Bay, Delaware.—The constant washing away of the bank has made it necessary to remove and rebuild the light-house structure four times since its first erection in 1831. The present station is now threatened with early destruction. The surrounding marsh is soft, yielding mud, and the

Fourth District.

building protected by its bulkhead being but 60 feet from high-water mark on the south and 125 feet on the east, the cost of further protection would be great and of uncertain results. This station is hardly of sufficient importance to justify the expense of the construction of an isolated site for its use. The present building is of wood, the outer walls being lined with brick laid in mortar; hence it would be unwise to attempt its removal over the soft marsh. The Board therefore recommends that a new site be purchased about 1,500 feet NNW. of the present site; also that a detached skeleton wooden tower, specially designed so that it could be moved if necessary, be built for the display of this light upon the proposed new site. It is estimated that this can be done at an expense not exceeding $8,500, and it is recommended that an appropriation of this amount be made therefor.

—. *Salem Creek light-station, southern side of Salem Creek, Delaware Bay, New Jersey.*—The following recommendation, made in the Board's last two annual reports, is repeated:

The establishment of a light-station here, at a cost not exceeding $800, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

NOTE.—An appropriation of $800 was made for that purpose by the sundry civil appropriation act approved August 18, 1894. Plans therefor are now being prepared.

383. Ship John Shoal, Delaware Bay, New Jersey.—The station was recently surrounded with heavy blocks, from about 2 to 6 tons each, of riprap stone, placed about 60 feet from the foundation cylinder to protect it from damage by running ice, principally, and from the action of the sea. Two channel approaches to the light were left open. About 1,669 cubic yards of stone were placed in position.

—. *Port Penn range (Reedy Island), at Port Penn, Delaware River, Delaware.*—Preliminary steps have been taken to determine the proper range and location.

388. Reedy Island, on lower end of Reedy Island, Delaware River, Delaware.—The piers of the dwelling and the banks were rebuilt and enlarged and various repairs were made.

389. Finns Point range, front, below Finns Point, Delaware River, New Jersey.—A driven well and pump were furnished for additional water supply and various minor repairs were made.

391. New Castle range, front, below New Castle, Delaware River, Delaware.—The sea wall was rebuilt, jetties were thrown for its protection, and various minor repairs were made.

394. Deep-Water Point range, rear, below Deep-Water Point, Delaware River, New Jersey.—The banks were rebuilt and various repairs were made.

395. Christiana beacon, on pier at the mouth of Christiana Creek, Delaware River, Delaware.—The new foundation pier was completed and

Fourth District.

an iron lantern post, with a fixed white lens lantern, was erected. The fourth-order red light was discontinued on January 31, 1894, and its illuminating apparatus and gas tanks were taken out and the frame tower was removed.

396. Christiana, at mouth of Christiana Creek, Wilmington, Del.—It is proposed to change the pierhead light, which is now a lens lantern, to a fourth-order light. This will be a decided benefit to the navigation of the Delaware. A fourth-order light would be seen without difficulty at a sufficient distance. It is therefore recommended that the white lens lantern on the pier at the end of the dike be replaced by the fourth-order light now on the dwelling, and it is further recommended that a white post light be estabished on a tripod in the grounds, or at the side of the dwelling, in place of the fourth-order lens to be removed from the tower on the house. It is estimated that this will cost not to exceed $9,100, and it is recommended that an appropriation of this amount be made therefor.

398. Cherry Island range, rear, above Edgemoor Iron Works, Delaware River, Delaware.—The boundary and other fences on the reservation were rebuilt.

399. Schooner Ledge range, front, mouth of Crum Creek, Delaware River, Pennsylvania.—The sea wall and banks were rebuilt and enlarged and various minor repairs were made. The frame lattice work day mark was removed from the top of the dwelling and a mast, with a hoop-iron cage, erected in the rear of the dwelling and showing above its roof, was substituted.

REPAIRS.

At each of the following-named stations repairs of greater or less extent were made during the year:

366. Absecon, N. J.
368. Hereford Inlet, N. J.
371. Cape May, N. J.
374. Delaware Breakwater Range (rear), Del.
376. Mispillion Creek, Del.
378. Fourteen-Foot Bank, Del.
379. Maurice River, N. J.
380. Egg Island, N. J.
382. Mahon River, Del.
386. Port Penn Range (front), Del.
392. New Castle Range (rear), Del.
393. Deep-Water Point Range (front), N. J.
396. Christiana, Del.
400. Schooner Ledge Range (rear), Pa.
402. Tinicum Island Range (rear), N. J.
405, 406, 407. Horseshoe Range, West Group, Pa.
411, 412. Schuylkill River Range (front and rear), Pa.
421. Fenwick Island, Del.

LIGHT-SHIPS.

369. Northeast end of Five-Fathom Bank light-vessel, No. 44, off the seacoast of New Jersey.—Repairs to the launch of this vessel were made. Some 7 tons of coal, a cord of wood, boat compass, boat covers, hydrometers, coal hod, paint, oil, japan, rope, rations, and grate bars were sup-

Fourth District.

plied. It is proposed to bring this vessel in during July, when she will be docked and the bottom will be cleaned and painted.

370. Five-Fathom Bank light-vessel, No. 40, off the seacoast of New Jersey.—This vessel was removed from her station on July 6, 1893, and light-vessel No. 37 was placed there. Light-vessel No. 40 was taken to Edgemoor light-house depot, when her anchors and chains were removed and the vessel was repaired. She was taken out on the railway, when it was found that her yellow-metal sheathing was so much worn as to need renewing. It was stripped off, the hull was calked from the keel to the metal line, and the vessel was resheathed with yellow metal. The hull was calked from the metal line up to the waterway; the spar and forecastle decks calked; a new foremast was put in; the standing rigging, the ironwork, etc., were refitted; new lanyards were supplied; preventer chains on the rudder were repaired; the cabin skylight was repaired; a new topmast or pole fitted to the mainmast; and two new boxes for the Gould pump were fitted. A new jib was supplied. New canvas cover for the forward lantern house, two masts for boats, four up-and-down fenders, two side-light boxes, one lantern winch repaired. The standing rigging of the mainmast was lifted, replaced, and supplied with new ratlines. The outside of the vessel was repainted. New battens fitted to the mainmast. The ends of deck plank aft, under the platform for the steering wheel, were renewed. The lantern houses were relined with yellow metal. A new grating was fitted under the steering wheel. A new beam, a new knee, a spliced beam, and two corner knees to the after lantern house were fitted. The fog-signal boilers and machinery were repaired. Wrenches, cement, stovepipe, bricks, paint, rope, rations, bedding, medicine, dishes, 34 tons of coal, and 1 cord of wood were supplied, and the vessel was placed on her station September 13, 1893.

420. Fenwick Island Shoal light-vessel, No. 52, off the seacoast of Maryland.—The decks of this vessel were calked. Stoves were supplied for heating the cabin and the forecastle, and the use of donkey boiler for heating purposes was discontinued. Paint, rations, piston rings, medicine, pipe tongs, rope, etc., also 63½ tons of coal and 1 cord of wood, were supplied.

422. Winter-Quarter Shoal light-vessel, No. 45, off the seacoast of Virginia.—The fog-signal boilers of this vessel failed on April 20, 1894, and since that time her bell has been used as a fog signal. Paint, oil, grate bars, lumber, medicine, new trysail, rope, etc., rations, 41 tons of coal, and 1 cord of wood, were supplied.

Steam tug International.—After the loss of light-vessel No. 37, as narrated in the Board's last annual report, there being no relief vessel in the district and the repairs on light-vessel No. 40 still being unfinished, the steam tug *International* was chartered at the rate of $125 per day for use as light-vessel on Five-Fathom Bank. She was

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anchored on the station on August 26, 1893, thus leaving the station unmarked for but two nights. The *International* marked the station until September 13, when light-vessel No. 40 resumed her station.

Relief light-vessel for the Fourth light-house district.—During the recent cyclones light-ship No. 37, stationed off Five-Fathom Bank, coast of New Jersey, Atlantic Ocean, in the Fourth light-house district, was wrecked. There is now no relief light-ship in the Fourth light-house district. The interests of commerce and navigation urgently require that a new vessel should be provided to replace the wrecked vessel at the earliest day practicable. It is estimated that the construction and establishment of a first-class light-vessel, with a steam fog signal, suitable for Five-Fathom Bank, will cost $70,000, and it is recommended that an appropriation of that amount be made therefor. When that is done the vessel now on Five-Fathom Bank can be used as a relief light-vessel, and can be held in reserve to take the place of any one of the light-vessels now on stations in the Fourth light-house district whenever any of them may become disabled.

Light-vessel for Overfalls, or South Shoal, entrance to Delaware Bay.—Petitions have been made during the past year to this office by the American Association of Masters and Pilots from Camden, N. J.; Boston, Mass.; New London, Conn., and from officers of the steam colliers and sea tugs of the Philadelphia and Reading Transportation Line for the establishment of a light-vessel at the Overfalls, or South Shoal, entrance to Delaware Bay. While the entrance to Delaware Bay is well lighted and can be entered with safety in clear weather, the entrance is difficult and dangerous in thick and stormy weather. Neither the whistling buoy on South Shoal, nor the Daboll trumpet on Delaware Breakwater, can be heard always at a safe distance. Mariners have been within half a mile of Delaware Breakwater with the Daboll trumpet in operation without being able to hear it. The entrance to the Delaware Bay is shoal on the northern side from Cape May to the Overfalls buoy, and "steep to" at Cape Henlopen. This makes it the more necessary that this point should be well marked by a light-vessel having a more powerful fog signal. It is estimated that such a light-vessel should be established here for not to exceed $70,000. Recommendation is therefore made that an appropriation of this amount be made for that purpose.

It is claimed that if the light-vessel is established, the following changes, all in the interests of economy, can be made:

The Delaware Breakwater front and rear lights can be discontinued.

The Cape May light can be changed from the first to the third order.

Two post lights can be established in place of the Delaware Breakwater front light, a red one to be exhibited from the present building, and a white one on the extreme western end of the ice breaker. These two lights can be attended by one keeper, to occupy the present dwelling.

Fourth District.

Reimbursement of seamen's losses.—The honorable the Secretary of the Treasury, at the instance of the Board, wrote to the Speaker of the House of Representatives on September 28, 1894, asking that proper measures might be taken to reimburse the legal representatives of Howard Selover, mate of light-ship No. 37, and George Richardson, a seamen on the same vessel, for the value of the clothing lost when they were drowned on the occasion of the foundering of that vessel. The amounts named in the sworn statements, which were transmitted and recommended by the inspector of the Fourth light-house district, were $77.25 in the first case and $50 in the other.

DAY OR UNLIGHTED BEACONS.

They are in good condition.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

369. Northeast end of Five-Fathom Bank light-vessel, No. 44, New Jersey.—The 12-inch steam whistle was in operation some 396 hours, and consumed about 26 tons of coal.

370. Five-Fathom Bank light-vessel, No. 40, New Jersey.—The 12-inch steam whistle was in operation about 938 hours from September 13, 1893, to June 30, 1894, and consumed some 11 tons of coal.

375. Delaware Breakwater, east end, Delaware.—This second-class Daboll trumpet was in operation about 382 hours, and consumed some 3 tons of coal.

378. Fourteen-Foot Bank, Delaware Bay, Delaware.—This second-class Daboll trumpet was in operation some 170 hours, and consumed about 1¼ tons of coal.

420. Fenwick Island Shoal light-vessel, No. 52, Maryland.—This 12-inch steam whistle was in operation about 180 hours, and consumed some 21 tons of coal.

422. Winter-Quarter Shoal light-vessel, No. 45, Virginia.—This 12-inch steam whistle was in operation some 145 hours from July 1, 1893, to April 20, 1894, and consumed about 7½ tons of coal.

BUOYAGE.

There were maintained last year on the seacoast from Squan Inlet, New Jersey, to Chincoteague Inlet, Virginia, 24 buoys; in Barnegat Inlet, New Jersey, 11 buoys; in Tucker Cove and Little Egg Harbor inlets, New Jersey, 12 buoys; in Absecon Inlet, New Jersey, 8 buoys; in Great Egg Harbor inlet and river, New Jersey, 13 buoys; in Townsend Inlet, New Jersey, 3 buoys; in Delaware Bay and River and Schuylkill River, 117 buoys; in Chincoteague Inlet, Virginia, 5 buoys; and in Metomkin Inlet, Virginia, 3 buoys; a total of 201 buoys.

The buoyage of the Delaware Bay and River, of the seacoast of the Fourth light-house district, and of Chincoteague Inlet was kept in order

by the steam tender *Zizania*. The buoys of Barnegat, Tucker Cove, Little Egg Harbor, Absecon, except the outer or sea buoy, a bell; Great Egg Harbor, except the outer or sea buoy, a first-class can; Townsend Inlet and Hereford Inlet, on the New Jersey coast were kept by contract, as were those of Metomkin Inlet, Virginia. The 67 iron ice buoys were in position in the Delaware Bay and River and gave satisfaction during the winter.

BUOYS PLACED DURING THE YEAR.

One second-class can, black, to mark wreck of sunken canal boat at the entrance to Salem Creek, New Jersey.

One bell buoy, black and white perpendicular stripes, as a sea or outer buoy of Absecon Inlet, New Jersey.

Four buoys, 3 third-class nuns, red, and 1 third-class can, black, to mark channel from wharf at Atlantic City, N. J., to Brigantine Beach.

Three buoys, 2 second-class cans, and 1 second-class nun, black and white perpendicular stripes, to mark entrance and channel into Townsend Inlet, New Jersey.

One spar buoy, red and black horizontal stripes, to mark location of rock off Gibson Point, Schuylkill River.

One spar buoy, black, placed in the bend of river below Harkness Point, Schuylkill River.

One spar buoy, red, to mark entrance to Schuylkill River.

Two spar buoys, red, placed to mark edge of channel between Harkness Point and Yankee Point, Schuylkill River.

One gas-lighted buoy, red, placed at the elbow of Cross Ledge Shoal, Delaware Bay.

One second-class can buoy, black, to mark entrance to Salem Creek, New Jersey.

One third-class nun buoy, black and white perpendicular stripes, to mark entrance to Mud Channel, Barnegat Bay.

One third-class can buoy, black and white perpendicular stripes, to mark entrance to Oyster Creek Channel, Barnegat Bay.

One third-olass nun, red, to mark edge of the shoal west of Barnegat light-house.

DEPOTS.

Edgemoor light-house and buoy depot.—The wharf of this depot is in a bad condition, and if its deterioration is allowed to continue unchecked the usefulness of the depot will soon be destroyed. Repairs are being made sufficient to enable the Board to carry on the work of the depot during the ensuing year, but in addition the following-named work should be done at an early day to enable the depot to fully serve its purpose. The whole basin should be dredged to a depth of 9 feet. At present about half the basin is bare at low water. All three of the

Fourth District.

inner cribs of the south wharf and the portions of the pier joining them ought to be rebuilt. The bulkhead wall should be entirely rebuilt, new decking and new sheet piling are needed in all parts of the piers, and new foundations are needed under the north wall of the storehouse.

The estimated cost of this work is—

North wharf	$6,930
South wharf	8,635
Bulkhead, etc	12,815
Dredging basin	2,420
Total	30,800

This amount will be needed in addition to the cost of the temporary repairs now being made to put the depot in a satisfactory condition. It is therefore recommended that an appropriation of $30,800 be made for this purpose.

Chincoteague Inlet, Virginia.—The spare buoys for Chincoteague and Metomkin inlets, Winter-Quarter Shoal and Ship Shoal, are stored here. It is also used as a depot for Assateague and Killick Shoal light-houses and for the care of boats from Winter-Quarter Shoal light-vessel. The depot occupies half of a small wharf, and the frontage of the wharf is inadequate to properly accommodate and secure the tender while lying there. The buoy house is not adapted to the care of the light-vessel's boats.

Absecon, Absecon Inlet, New Jersey.—The following recommendation made in the Board's last three annual reports is renewed:

> An appropriation of $1,500 was made by the act approved on October 2, 1888, for the purchase of a site and the erection of a buoy depot at this place. It has been found that, after paying for the site and for the legal services incident to its purchase, the balance of the appropriation remaining is insufficient for the construction of a depot building. It is estimated that this work can be done for $2,000.

NOTE.—An appropriation of $1,200 was made by the sundry civil appropriation act approved August 18, 1894, for that purpose. The work will be done as soon as practicable.

Cape May, New Jersey.—The following recommendation made in the Board's last three annual reports is renewed:

> An appropriation of $750 was made by the act approved on October 2, 1888, for the purchase of a site and the erection of a boathouse for light-ships' boats at this place. The purchase of the site for a boathouse has been completed, and it is found that the balance of the appropriation is insufficient for the erection of a suitable structure. It is estimated that this work can be done for $800.

NOTE.—An appropriation of $500 was made by the sundry civil appropriation act approved on August 18, 1894, for that purpose. The work will be done as soon as practicable.

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TENDERS.

The Zizania.—This steamer was employed throughout the year, except during 61 days, while she was laid up for repairs. On October 7, 1893, the crank of the low-pressure starboard engine broke, and the vessel was laid up for repairs. The new boiler, etc., being built was completed in October, 1893. While the repairs to the crank were in progress, the old boiler was removed and the new one, with appurtenances, placed in the vessel and the necessary connections were made. The repairs were completed, and the tender went into service November 13, 1893.

On April 23, 1894, cracks developed in both slabs of the cranks of the high-pressure engines, so as to render them unsafe, and two new cranks were put in. The vessel on May 19, 1894, resumed her regular duties.

The tender was engaged in attending to the buoyage of the district, towing light-vessels to and from their stations, and in delivering fuel and supplies to light-houses, light-vessels, and post lights. Four trips were made to the general depot, Tompkinsville, N. Y., for supplies and buoys. She replaced and restored 44 buoys, changed 125, placed 8, painted 6, shifted 4, and 2 were removed. She landed 132 tons of coal and some 16 cords of wood at 25 light-stations, and 146 tons of coal and 4 cords of wood at 4 light-vessels, and 6 tons of coal at one fog signal. The crew was employed 68 days at Edgemoor light-house depot and at the iron pier at Lewes. She delivered the annual allowance of provisions to 4 light-vessels and 11 light-stations. She also conveyed the inspector to the light-stations of the district to inspect them, and she delivered the necessary supplies to the stations. In doing this she steamed some 16,056 miles and consumed about 901 tons of coal and 6 cords of wood. Necessary supplies, such as rope, oil, waste, soda, paint, baskets for coaling stations, packing, etc., were furnished.

The new boiler has so far proved satisfactory.

FIFTH DISTRICT.

The Fifth district extends from Metomkin Inlet, Virginia, to include New River Inlet, North Carolina, and embraces part of the seacoast of Virginia and North Carolina, all of Chesapeake Bay, the sounds of North Carolina, and the rivers tributary thereto.

Inspector.—Commander Yates Stirling, U. S. Navy.

Engineer.—Capt. Eric Bergland, Corps of Engineers, U. S. Army.

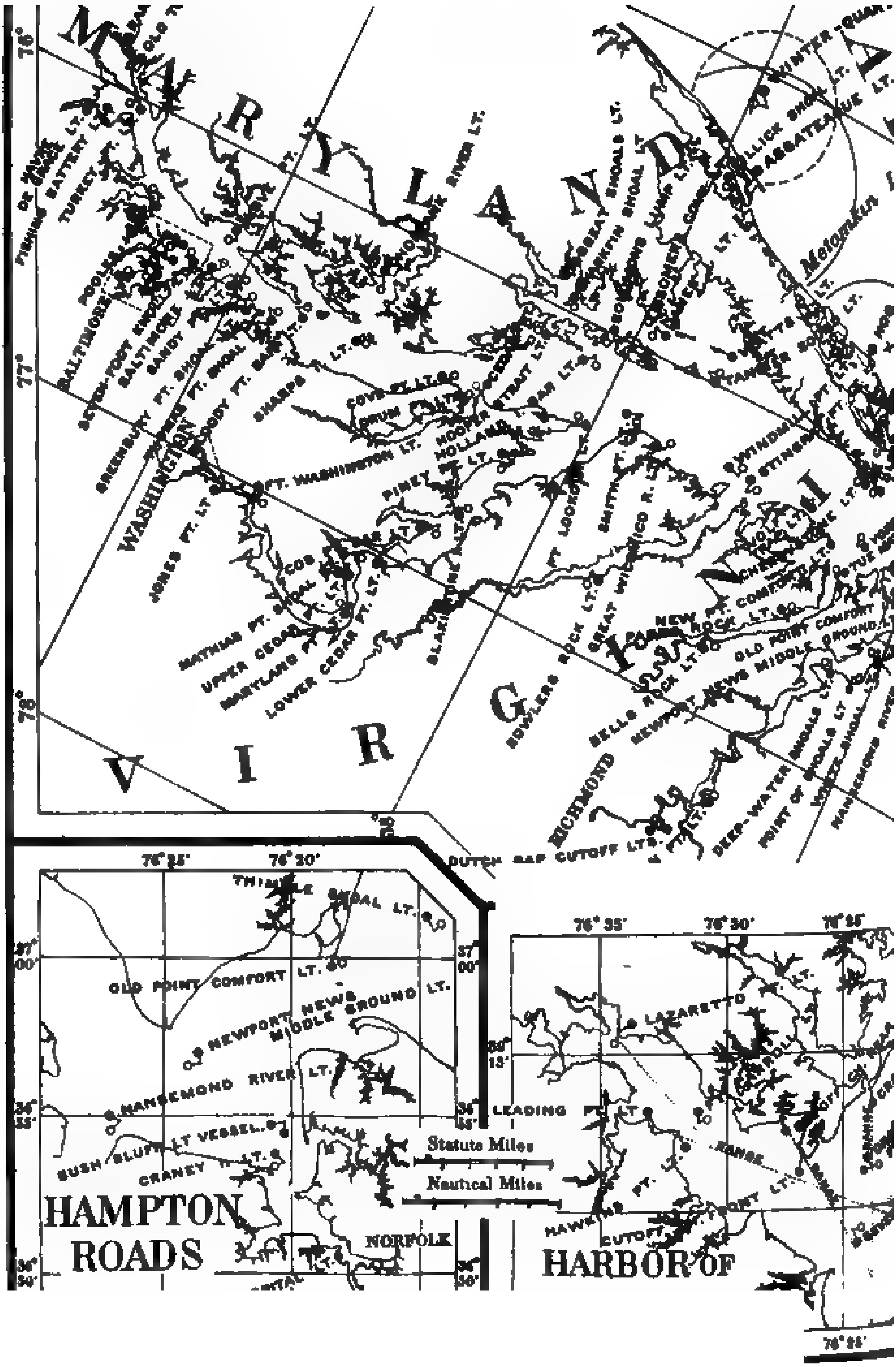
In this district there are :

Light-houses and beacon lights, including 2 post lights	114
Light-ships in position, including tender *Holly*	3
Day or unlighted beacons	10
Fog signals operated by steam or hot-air engines	3
Fog signals operated by clockwork	64
Whistling buoy in position	1
Bell buoy in position	1
Other buoys in position, including pile buoys and stakes	1,156
Steamers *Maple* and *Violet*, buoy tenders, and for supply and inspection	2
Steam launch *Bramble*, used to supply gas to the beacons in the sounds of North Carolina	1
Sharpie (and gas tank) for supplying beacons and coast stations	1
Steamers *Jessamine* and *Thistle*, for construction and repairs	2

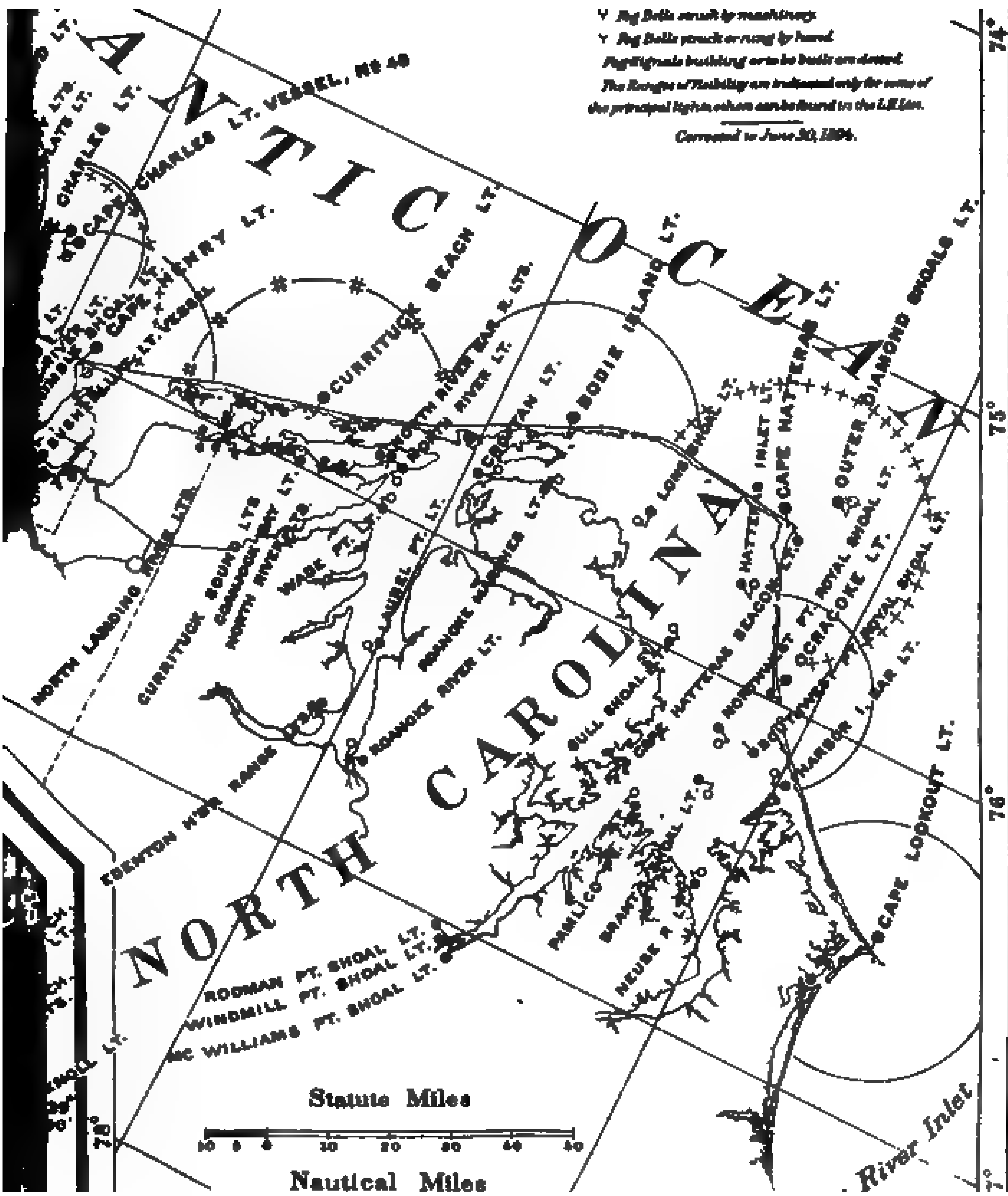
LIGHT-HOUSES.

425. Hog Island, Great Machipongo Inlet, seacoast of Virginia.—This station is in bad order, but no repairs were made in view of the fact that it is soon to be replaced by a better-equipped station on a new site. Owing to lack of funds, it was impracticable to undertake the work of preparing the foundation of the new tower, or any other operations at the new station. The $30,000 appropriated by the act approved March 3, 1893, was expended in preliminary work and in partly paying for the iron tower, which is nearly completed at the contractor's shops. About $75,000 more will be required to complete and properly equip the new light-station, and an appropriation of this amount by Congress is urgently recommended.

The construction of a permanent wharf and roadway leading to the site, under a specific appropriation therefor, was commenced early in April, the deed to the necessary land having been approved by the Attorney-General of the United States. The wharf is 930 feet long and 12 feet wide, with a pierhead 30 feet by 72 feet. It is constructed of cast-iron sleeve columns resting on and embracing wooden piles, except the shore end, which is built of pine piles without sleeves. In its construction there were used 204 piles and 38,000 feet of pine decking. It was completed during May.



MARYLAND
VIRGINIA
WASHINGTON
RICHMOND
TURKEY PT. LT.
FISHING BATTERY LT.
POOLES
BALTIMORE
SEVEN-FOOT KNOLL
SANDY PT.
GREENBURY PT. SHOAL
SHARPS
COVE PT. LT.
DRUM PT.
HOOPER STRAIT LT.
FT. WASHINGTON LT.
JONES PT. LT
PINEY PT.
MATHIAS PT. SHOAL
UPPER CEDAR
MARYLAND PT.
LOWER CEDAR PT. LT.
SMITH PT.
WICOMICO R.
BOWLERS ROCK LT.
NEW PT. COMFORT
BELLS ROCK LT.
NEWPORT NEWS MIDDLE GROUND
OLD POINT COMFORT
DEEP-WATER SHOALS LT
POINT OF SHOALS LT
WHITE SHOAL LT.
DUTCH GAP CUTOFF LTS.
ASSATEAGUE LT.
76° 25'
76° 20'
37° 00'
36° 55'
36° 50'
THIMBLE SHOAL LT.
OLD POINT COMFORT LT.
NEWPORT NEWS MIDDLE GROUND LT.
NANSEMOND RIVER LT.
BUSH BLUFF LT VESSEL
CRANEY I. LT.
HAMPTON ROADS
NORFOLK
Statute Miles
Nautical Miles
76° 35'
76° 30'
76° 25'
LAZARETTO PT. LT.
LEADING
CUTOFF
HARBOR OF


ATLANTIC OCEAN
NORTH CAROLINA
CAPE CHARLES LT. VESSEL, NO 46
CAPE HENRY LT.
CURRITUCK BEACH LT.
BODIE ISLAND LT.
CAPE HATTERAS LT.
OUTER DIAMOND SHOALS LT.
HATTERAS INLET LT.
HATTERAS BEACON
OCRACOKE LT.
CAPE LOOKOUT LT.
NORTH LANDING RIVER LTS.
CURRITUCK SOUND LTS.
NORTH RIVER LTS.
WADE PT. LT.
LAUREL PT. LT.
ROANOKE RIVER LT.
EDENTON N'W. RANGE LTS.
GULL SHOAL LT.
PAMLICO
NEUSE R.
ROOMAN PT. SHOAL LT.
WINDMILL PT. SHOAL LT.
MC WILLIAMS PT. SHOAL LT.
Corrected to June 30, 1894.
Statute Miles
10 5 0 10 20 30 40 50
Nautical Miles
River Inlet
74°
75°
76°
77°
78°

Fifth District.

NOTE.—An appropriation of $75,000 was made in the sundry civil appropriation act approved August 18, 1894, for the completion of this light-station. Plans for all the required structures have been approved, and the work of construction will be pushed as rapidly as practicable.

427. Cape Charles, on Smith Island, entrance to Chesapeake Bay, seacoast of Virginia.—The station is much out of order but only absolutely necessary repairs were made pending its early establishment on a new site. The construction of the iron tower for the new station was commenced under contract in June, 1893, and on June 30, 1894, it was completed at the contractors' shops, except the top or lantern section. Six of the sections, comprising about 133 feet in height, of the tower were delivered at the site by the contractors, and 4 of the sections, or 96 feet in height, of the tower were erected by them on the foundation prepared for the new structure by the engineer's working party. The framing of the dwellings and outhouses at the light-house depot at Baltimore, Md., was begun in July. On October 19 the material for the stable and woodsheds and the working plant, and part of the material for the construction of a temporary wharf for landing purposes were sent to the site. The stable and woodsheds were erected to serve as quarters for the working party until the completion of the station, a road was graded from the landing to the new light-house site, and the construction of the wharf was commenced. The latter, 1,345 feet in length, with a receiving pier 43 feet by 60 feet, was finished in November, and a tramway was built from the pierhead to the light-house site. In December 3 storehouses were partly erected, and work on the foundation of the tower was commenced. The storehouses were finished in January, molds were made for the foundation piers, the iron caisson used as a cofferdam was sunk, and the center concrete pier of the tower foundation was built up to within 18 inches of the top. In February the center pier was completed, the iron caisson was shifted as required, the requisite molds were made, and 5 outer piers were finished. The other 3 piers were completed in March, the surface of the ground was leveled up to within a foot of the top, the piers were covered by boards, and the anchor bolts were protected by means of tin caps until the arrival of the ironwork of the tower. Excavations were made and brick foundations were laid for the 2 dwellings to be occupied by the assistant keepers. Meanwhile the framing of these buildings and of the principal keeper's dwelling had been progressing at the light-house depot, and on January 14 and March 20 the materials for these dwellings were shipped to the site and duly landed.

The following is the status of the work on June 30, 1894:

The two assistant keepers' dwellings are under roof and the upper floors have been laid. The workshop and the oil house are under roof, ready for the inside work which is nearly completed at the depot. The stable is finished, except the second coat of paint. Four wood-

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sheds, etc., are built, but are yet to be moved to permanent foundations to be prepared for them. Nothing has been done toward the erection o the principal keeper's dwelling and the cisterns. The working party was disbanded and left the station on June 30, as the insects, particularly mosquitoes, were so numerous and annoying that it was impracticable for the men to continue work.

430. Old Point Comfort, entrance to Hampton Roads, Virginia.—An iron oil house, capable of storing about 1,000 gallons of mineral oil, was purchased and delivered at the light-house depot. It will soon be erected at the station.

—. *Dollers Point and Hog Island Wharf, James River, Virginia.*—The following recommendations, made in the Board's annual reports for the last four years, are renewed:

> Lights have been maintained at these points for several years by private enterprise, and their value to the public interests of navigation is now evident. It is therefore recommended that proper measures be taken for establishing range lights at Dollers Point to guide vessels through the narrow and shallow channels, known as Goose Hill Slough, between Hog Island and Jamestown Island; also for the establishment of an inexpensive light on the wharf at Hog Island, to lead the way through another difficult channel from Deep-Water Shoals light to the north point of Hog Island, where an abrupt turn is made to enter Goose Hill Slough. The estimated cost of these lights is $2,500, and it is recommended that this amount be appropriated therefor.

442. Back River, entrance to Back River, Virginia.—The keeper's dwelling, which was too small to accommodate his family, was enlarged by the addition of another story and by other improvements, so that three habitable rooms were gained. Various repairs were made. The small building used as a kitchen by the working party was left as a summer kitchen for the keeper.

451. Pages Rock, York River, Virginia.—At the date of the last annual report the metal work of this light-house, consisting mainly of the iron substructure, was finished by the contractors and was stored at the light-house depot, at Baltimore, awaiting the completion of the wooden superstructure. This was soon ready, and on July 21 it had been loaded on scows, together with the metal work and all the apparatus and materials for the erection of the light-house. The light-house tenders *Jessamine* and *Thistle* towed the scows and transported the working party. A platform was built from which the work of erection could be carried on, which involved the driving and capping of 81 piles, besides the laying of the necessary deck planks. The engine, boiler, and pile-driver were placed on the platform, and one of the wooden foundation piles of the light-house was driven and fitted with the cast-iron sleeve column forming one of the supports of the structure. The driving of the other 6 foundation piles was completed on August 2, and the iron sleeve columns, braces, sockets, and radial and perimeter beams were put in place, after which the erection of the

superstructure was commenced. Work on the latter was pushed rapidly forward, and it was finished, with the exception of the painting; the lantern was set; the boat davits, the hoisting apparatus, and the fog-bell machine were put in position, and everything was made ready for the reception of the lens by August 29. The working platform was then removed, several of the piles being left standing above the water to afford protection against any movement of the ice upon the structure that might occur during the ensuing winter. The working party returned to Baltimore, except two men who were left to finish the painting and await the arrival of the lens apparatus and the keepers. On September 30 the light was formally exhibited for the benefit of mariners.

The new light-house is hexagonal in plan, supported by steel beams on seven hollow cast-iron columns, which in turn rest on and envelop the same number of pine piles driven firmly into the shoal. These sleeve columns are 27 feet 9 inches in length, of an interior diameter at the lower end of 16 inches and narrowing to 4 inches at the top. The thickness of metal at either end is 1½ inches, increasing to 2 inches in the intermediate part which extends from low-water level to just above the sockets which receive the braces. This is the area subject to the greatest strain. The columns penetrate 6 feet below the surface of the shoal, and are rigidly secured above high-water line by a system of diagonal and horizontal braces. The light is fixed white of the fourth order. During thick and foggy weather a bell is struck by machinery every 15 seconds.

454. Wolf Trap, on a shoal between York and Rappahannock rivers, Chesapeake Bay, Virginia.—The light-house which was carried away by the ice in January, 1893, was a wooden building on iron screw piles. It was determined to replace it by a structure which could withstand such attacks, by means of its inherent weight and solidity. The caisson style of foundation was therefore decided upon, and as soon as an appropriation for this purpose had been made by Congress the preparation of the plans and specifications was commenced. Proposals were invited in July, 1893, for furnishing the metal work of the foundation pier, and also for constructing and sinking the pier. The former comprised the cast-iron cylinder, and the latter the construction of the wooden caisson at Baltimore, Md., its launching and transportation to the site of the light-house; the sinking of the caisson and superimposed cylinder to the depth of 18 feet below the surface of the shoal; the construction of a cistern; the filling of unused spaces in the cylinder with concrete and the deposition of riprap stone in the depressions in the shoal around the foundation pier. The lowest bid received for making the cylinder was $6,950, and for the construction and sinking of the foundation pier, $31,150. Contracts were made in these amounts in August, and in September the lower three sections of the iron cylinder were delivered

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at the light-house depot at Baltimore, Md., as stipulated. The framing of the timbers forming the caisson was commenced on October 17, at the depot by the contractors. The caisson was finished in November, but it was not until late in December that there was a tide sufficiently high to permit its being launched. The lower sections of the iron cylinder were then placed on the caisson, and on January 13 these parts of the structure were towed to the site. The caisson was not grounded on its site until nearly a week later on account of rough weather experienced on the way down the bay. On February 28, the air lock and pneumatic machinery were put in, and on March 5 the sinking of the structure was commenced. In two weeks the required depth was reached and the filling of the caisson with concrete was completed. The upper sections of the iron cylinders were delivered at the depot in November, 1893, and were taken to the site by the contractors from time to time as needed. On April 9, 1894, the foundation pier was finished ready for the superstructure, and it was found by test to be entirely level. The materials for the superstructure have nearly all been purchased and delivered at the depot, and are being loaded on scows preparatory to transportation to the site. The steamer *Holly*, which was on temporary duty as a light-vessel to mark the site of the former light-house, was replaced on July 31, 1893, by light-vessel No. 46, which is still there. She shows two fixed white reflector lights, one at each mast-head, and she will remain until the exhibition of the light from the new light-house, which it is hoped may take place by September 1, 1894. (*See* Appendix No. II.)

—. *Beacon lights on Rappahannock River, Virginia.*—The following statement made in the Board's last annual report is repeated:

> The trade on this river is growing rapidly. At certain seasons of the year, ten or more large steamers make weekly trips here, carrying vegetables, fruits, and the like. As the river is inadequately lighted, these steamers with their perishable freight often have to tie up at night for the lack of guiding lights. The Board recommends the establishment of a red light to be shown from an iron beacon placed at the entrance to Carters Creek, at a cost not exceeding $3,000, and of three beacon lights to be shown from poles placed on or near Sharp's wharf, below Suggett Point, on Tappahannock wharf, and on Taylor's wharf, at an estimated cost of $100 each. Recommendation is made that $3,300 be appropriated for this purpose.

463. *Smith Point, mouth of Potomac River, Virginia.*—In September one of the cast-iron struts, which was broken by the ice of the previous winter, was renewed and a horizontal brace was repaired by placing a collar around the break and securing it to the broken brace by means of steel set screws. A boat hoister was placed in position and various repairs were made.

464. *Point Lookout, entrance to Potomac River, Maryland.*—An iron oil house, capable of storing about 1,000 gallons of mineral oil, was purchased and will be erected at the station at an early date.

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467. Cob Point Bar, entrance to Wicomico River, Maryland.—Arrangements were made in July for the exhibition on August 15, 1893, of a red sector in this light to mark, with one in the Lower Cedar Point light, a dangerous lump in the Kettle Bottom Shoals. On April 10, 1894, an additional red sector was established to cut Edge of Channel buoy No. 4, and Blakistone Spit buoy No. 3, marking part of the Dukehart Channel.

468. Lower Cedar Point, Potomac River, Maryland.—The wooden superstructure of this light-house was on December 25, 1893, entirely destroyed by fire. An investigation into the origin of this fire was held, but the cause was not definitely ascertained. A lens lantern was immediately placed on the iron substructure to indicate its position at night. The locality needs proper lighting at once, as it indicates an important turning point in the Potomac River. It is estimated that a proper structure will cost not to exceed $75,000, and it is recommended that an appropriation of this amount be made therefor.

469. Mathias Point Shoal, Potomac River, Maryland.—New landing ladders were put up, and the fuel platform under the house was repaired.

475. Solomons Lump, Kedge Straits, Chesapeake Bay, Maryland.—At the date of the last annual report plans were being prepared for the new structure which is to replace the one carried away by the ice in January, 1893. They provided for the erection of a screw-pile structure of strong parts, but the Board, after mature consideration, decided to incur no risks of the destruction of another light-house by the ice, and concluded to erect, instead, a structure which by its mass and weight could oppose an effective resistance to any movement of the ice. The only obstacle to this course was the limited amount, $30,000, appropriated for the reestablishment of the light-house; but it was found, owing to an advantageous contract for the caisson of the Wolf Trap light-house, that enough money could probably be saved from the appropriation for the latter work to admit of the construction of a caisson style of light-house at Solomons Lump, if Congress would authorize the use of this balance for the purpose proposed. This authority was granted by act approved December 21, 1893. The necessary drawings and specifications are now being made.

—. *Point No Point, west side of Chesapeake Bay, between Potomac and Patuxent rivers, Maryland.*—The following recommendation was made in the last three annual reports:

> There is a stretch of about 30 miles between the Cove Point and Smith Point lights which should be better lighted. For a part of the distance navigators are without a guide, where a deviation from their sailing course might carry vessels of heavy draft onto dangerous shoals. There are many of this class of craft now trading to Baltimore, and their number is increasing. A light-house on the shoal off Point No Point is therefore urgently needed.

In view ot recent damages by ice to screw-pile structures in Chesa-

peake Bay, the Board is now of opinion that only caisson structures should be used where such dangers exist, and that a caisson structure should be erected at this place. It is estimated that it may cost, in view of the possibly soft bottom, not to exceed $70,000. Recommendation is therefore made that an appropriation of this amount be made therefor.

479. *Cedar Point, mouth of Patuxent River, Chesapeake Bay, Maryland.*—A tract of land containing about 1½ acres was purchased in March for the site of this light-house. Borings were made to ascertain the character of the foundation. Plans and specifications of the structure proposed to be erected are now being made.

—. *Swan Point Bar, east side of Chesapeake Bay, opposite Bodkin Point, Maryland.*—The following recommendation, made in the Board's annual reports for each of the last six years, is renewed:

> Swan Point Bar is a very important turning point for vessels navigating the bay. Steamers reach it by long courses, whether approaching it from the north or south. A light on the extreme point of the bar, in about 12 feet of water, would be of great use to vessels navigating the bay, whether bound for Baltimore or for other points. This location is exposed to the large fields of ice which move in the bay.

In view of recent damages by ice to screw-pile structures in Chesapeake Bay, the Board is now of opinion that only caisson structures should be placed where such dangers exist, and therefore that only a caisson structure should be erected at this place. It is estimated, in view of the possibly soft bottom, that it will cost not to exceed $70,000. Recommendation is therefore made that an appropriation of this amount be made therefor.

—. *Baltimore light and fog-signal station, Patapsco River, Chesapeake Bay, Maryland.*—The following recommendation, made in the Board's last four annual reports, is renewed:

> The principal difficulty in the navigation of the Cutoff Channel occurs at its junctions with the Craighill and Brewerton channels. At these places the channel has been widened, and the intention is to still further increase the width. For vessels of small draft there is no difficulty in entering or leaving Baltimore Harbor. It is only in the day time, when it is difficult to distinguish the buoys which mark the turning points, and for large steamers, that additional aids to navigation are needed. A light-house is most wanted at the mouth of the Cutoff Channel, i. e., where this channel joins the Craighill. On account of the impressible character of the shoal, and the liability to damage or destruction by fields of moving ice, no light-house other than an expensive one can be made permanent. The estimated cost of a suitable structure is $60,000.

NOTE.—An appropriation of $60,000 was made for the establishment of this station to mark the entrance to Baltimore Harbor in the sundry civil appropriation act approved on August 18, 1894. The plans for the structures are now being made, and the work will be pushed as rapidly as is practicable.

491. *Seven-Foot Knoll, mouth of Patapsco River, Chesapeake Bay, Maryland.*—A fuel platform was built under the superstructure in October,

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and various minor repairs were made. An examination of the substructure by a diver showed that all the water braces and some of the cast-iron sleeves to which they were secured had been broken by the movement of heavy masses of ice against the light-house. The foundation piles were found to be comparatively sound, but the clusters of oak piles placed around the light-house in 1884 as an ice breaker had disappeared. As the structure was somewhat weakened by the loss of its water braces and the breaking of the cast-iron sleeves, it was decided to deposit heavy riprap stone around the light-house to strengthen it and receive the brunt of any future attacks by the ice. Accordingly, in November about 790 cubic yards of stone were properly distributed about the site.

—. *White Rocks, Patapsco River, Maryland.*—There is a group known as the White Rocks, standing about 15 feet above high-water level at the entrance to Rock Creek, a stream emptying into the Patapsco River between the Seven-Foot Knoll light-house and Fort Carroll, on the west side of the river. They are now surrounded by deep water, and the creek in their vicinity forms an excellent harbor for the numerous small craft engaged in the oyster and garden-truck business, and plying to and from Baltimore. This trade gives constant employment to a large number of men, "oystering" in the winter months and "trucking" during the rest of the year. In stormy weather their vessels resort for safety to the harbor in Rock Creek, the only available one for many miles on the river, but the rocks at the entrance, in the absence of light or fog bell, constitute an obstruction and a source of serious danger. An inexpensive structure, supporting a light and fog signal, will do all that is needed by that class of vessels. It is estimated that a light and fog signal can be placed on White Rocks, at the entrance to Rock Creek, Patapsco River, Maryland, for not exceeding $10,000, and it is recommended that an appropriation of this amount be made therefor.

492, 493. Cutoff Channel range, Patapsco River, Maryland.—A severe storm on August 28, 1893, carried away the bridge, built of timber and stone, connecting the front beacon with the shore, and washed out the strip of land originally purchased for a means of communication between the beacon and the keeper's dwelling on shore. Hence it was deemed best to fit the beacon for occupancy by the keeper rather than to undertake to rebuild the bridge and purchase a new right of way. The adopted plan included the providing of a suitable boat for the keeper and the erection of a boat landing and davits. These changes were made in October, when some minor repairs were also made to the station. An oil house, rectangular in plan, constructed of heavy sheet iron and with room for 1,000 gallons of mineral oil, was purchased and delivered at the light-house depot. It will soon be erected on its site.

494. Fort Carroll, Patapsco River, Maryland.—A new water tank, to replace the old one, was put in position and minor repairs were made.

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497. Lazaretto Point, Baltimore Harbor, Maryland.—A part of the light-house site is low ground, which at times receives the drainage from adjoining property. An attempt is being made to rectify this by transferring earth from the elevated portion of the grounds to the low area. About 288 cubic yards were moved.

498. Pooles Island, off the mouth of Gunpowder River, Chesapeake Bay, Maryland.—On April 10, 1894, two red sectors were placed in this light in order to indicate turning points in the channel to the eastward of the light-house.

501. Havre de Grace, mouth of the Susquehanna River, Maryland.—Severe storms in October, accompanied by unprecedentedly high water, caused considerable damage to the coal house, fences, board walks, and the like. These were repaired or rebuilt, and the débris was cleared away.

504. Currituck Beach, seacoast of North Carolina.—A topographical survey of the light-house site was made.

505. Bodie Island, seacoast of North Carolina.—A topographical survey of the light-house site was made.

506. Cape Hatteras, seacoast of North Carolina.—A topographical survey of the light-house site was made. Various minor repairs were made.

508. Outer Diamond Shoals, off Cape Hatteras, North Carolina.—The Board determined that the failure of the attempt in 1891 by the contractors, Messrs. Anderson & Barr, to place the substructure of a light-house on the Outer Diamond Shoal, off Cape Hatteras, should not end the matter, but that a second attempt to found a light-house on the shoal should be made. To this end it was decided to have borings made at the locality so as to ascertain what kind of structure would be best suited to existing conditions. A boring apparatus was designed, consisting of a skeleton iron frame, 20 feet square and 32 feet high, surmounted by a platform from which operations could be carried on. This framework was composed principally of iron tubing 7⅝ inches in diameter. Through the four corner tubes passed solid wrought-iron piles, 6 inches in diameter and 50 feet long, provided at the lower ends with cast-iron disks, 3 feet in diameter, for firm anchorage in the shoal. The apparatus was equipped with a system of water pipes and hose for the application of the water-jet in sinking the disk-fitted piles. That it might be floated to the site and better manipulated when there, two pontoons were provided, one attached to each of two opposite sides in such manner that it could easily be liberated when desired.

After the delivery at the Lazaretto depot of the different parts of the apparatus, they were loaded on the barge and taken to Newport News, Va., on May 10, 1894, where the use of suitable shears and derricks was secured. On May 17 the complete apparatus, with pontoons connected, weighing 46 tons, was lifted from the barge and placed in the water by

means of the large shears of the Newport News Shipbuilding and Dry Dock Company.

An account of the subsequent operations is best given by the following extract from the report of Mr. Julius E. Rettig, superintendent of construction of the Light-House Board, under whose personal charge the work was conducted:

On Monday morning, May 21, I took my quarters on the *I. D. Jones*, the Merritt Wrecking Organization's steamer, to wait for suitable weather. On Wednesday morning, May 23, I telegraphed the New York office of the wrecking organization, to have their steamer report at Newport News as soon as practicable, and at 12 o'clock noon the steamer was made fast to the wharf at the shipyard, close to the apparatus, where it required but a short time to drill the intelligent crew of the vessel for the work to be performed at the site. At 1 p. m. on Wednesday, May 23, the 7½-inch towline, connected to the structure by a long rope bridle, took up its slack and we left port on our long journey, with a speed of from 3 to 3½ miles per hour. Nothing unusual occurred on our journey, the apparatus floated and towed like a well-designed vessel, and had it not been for the leakage of the pontoon on the port side of the structure, which made water at the rate of three-fourths cubic foot per hour, and which was pumped at sea every 12 hours, the apparatus required no special attention. In leaving the capes, a heavy swell from an easterly direction, caused by the storm on the 21st of May, was met, but as it had little effect upon the structure no further notice was taken of it, and we proceeded on our journey without making a single stop.

On Friday morning, May 25, we arrived at Cape Hatteras. I located the position of our steamer and we proceeded on our new course toward the buoys, which came in sight at 1 p. m. The tide and the sea were not suitable at the time for grounding the structure, and I contented myself on that day with taking soundings on a line from deep water to the buoys in range of the main light at Hatteras. Finding that the soundings were exactly as indicated to me in a letter from Lieut. Commander Garrett, U. S. Navy, we anchored at a distance of about 2 miles from the buoys on the east side of the shoals, where we remained, not having the least anxiety about bad weather, until Sunday morning at 7 o'clock, when all indications and conditions of the weather were such that the grounding of the apparatus could be attempted. High tide occurred at the shoals at 11:30 a. m. At 7 a. m. we had everything ready for work, the anchors for mooring the steamer alongside the structure after it had been grounded were ready to let go at a moment's notice; the vessel slowly approached the final resting place of the apparatus. At 11 a. m. the men were stationed on the structure, and at 11:30, when a moderate swell and not only a choppy sea but a strong current prevailed around us, the apparatus struck bottom, the valves in the pontoons were opened, and within 15 minutes the pontoons, which had so faithfully carried the structure, were liberated and floated off in a southeast direction, impelled by a current too strong to enable us to save them without the sacrifice of much valuable time. While all this was going on the steamer's crew unfastened the towline and placed the moorings at the corners of a square having a circumscribed circle of from 600 to 700 feet in diameter, with the structure located at its center, and at 1 p. m. the vessel was securely moored alongside the framework and ready to furnish water under pressure through two 2½-inch hose for driving the four piles by which the structure was to be secured to the bottom. The first pile was sunk to the contemplated depth of 13 feet into the sand and secured to the structure within 10 minutes; the second pile went like the first; the third was bearing upon the sand, and as the water would not discharge from the openings of the lower disk, it required underwashing by a 2-inch pipe to start circulation, and when this took place the third pile went successfully into its place. The fourth pile

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started all right, but in its fall broke the T of the pipe, which conducted the water to the disk. The T was replaced by another, the disk, around which the sand had settled, was underwashed like that of the third pile, and the pile went down like the others, and at 2 p. m. the structure was secured and stood firm on the dreaded shoal.

The 5-inch pipe through which borings were to be obtained was then screwed together and washed into the sand to a depth of 40 feet below the surface of the shoal, and when this was accomplished a squall from the southwest forced us to discontinue our work. At 4 p. m. the steamer's moorings were unfastened and soon after we were on our way to our old anchorage.

During the night the weather became settled again. On Monday morning a perfect calm prophesied a day which in reality could not be better and more suitable for our work. The steamer went under way at 5:30 a. m. It was moored alongside the beacon again at 7 a. m., when within three hours the 3½-inch and 2-inch pipes were sunk as contemplated and the borings to a depth of 105 feet below the surface of the shoal were secured. The water for washing the piles and pipes was furnished by the steamer's wrecking pump under pressure of 120 pounds per square inch, but this pressure had to be reduced when the 3½-inch and 2-inch pipes were nearly sunk to their required depths, for the friction of the water and sand on the outer surfaces of the pipe was so great that it stopped the descent of the pipes by their own weights. The borings, which were brought up in the annular space between the pipes, were caught in a canvas bag above the surface of the sea and consisted mainly of fine alluvial sand. * * * The structure was then cleared of all unnecessary planks and timbers, the moorings of the vessel were taken up, and at 11 a. m. on Monday, May 28, we left for Norfolk, Va., where we arrived at 3 a. m. on May 29 without having had a single accident during our undertaking.

The structure is surmounted by a mast 52 feet high, crossed with small pieces of board, to serve as a day mark.

In consequence of the successful establishment of the iron boring frame the Board, at its session of June 4, 1894, directed the engineer secretary to have plans prepared for a skeleton iron structure to be supported on heavy iron piles, which are to be driven by the water jet; the tower to contain quarters for the keepers, a fog-signal apparatus, and a hyperradiant lens. Such plans are now being drawn in the office of the Board.

526. Laurel Point, Albemarle Sound, North Carolina.—A working party was sent on the the tender *Jessamine* in September, with the necessary materials and plant, to repair the injuries done by ice to this light-house. Heavy timbers were laid on the horizontal braces, around corner and center piles, and on these supports jackscrews and blocks were placed. After the removal of the fuel platform from under the house the superstructure was lifted from the foundation and blocked up, the broken columns were removed from the sockets, and the seven new columns were inserted in their places. The house was lowered on to the new columns, all of the tension braces were replaced, and the new work was painted. The fuel platform was restored to its position and the jackscrews and temporary supports were removed. Repairs of a general character were also made.

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—. *Alligator River, at or near Great Shoal, mouth of Alligator River, North Carolina.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

There are no lights on the south side of Albermale Sound, between Croatan and Laurel Point light-houses, a distance of about 30 miles. Alligator River furnishes the only harbor in this distance. The general and local interests of navigation are of sufficient magnitude to justify the erection of a light-house at this locality. It can be built at an estimated cost of $20,000. Recommendation is made that an appropriation of this amount be made therefor.

—. *Blockade Shoal, off Pork Point, on Roanoke Island, Croatan Sound, North Carolina.*—The following paragraph from the Board's reports for the last seven years is repeated and the recommendation therein renewed:

There are eleven steamers running regularly, together with a large number of sailing vessels passing this point. Much property has been destroyed and many serious accidents have occurred in the vicinity for the want of a light, and the navigation of these waters is dangerous and much dreaded. The obstructions to the westward of the narrow channel, constructed during the war of the rebellion, have never been removed. This is also a turning point for vessels navigating the sound, and steamers, after leaving Croatan and Roanoke Marshes lights for this point can make it by steering a single course only. The Board, therefore, is of opinion that a light-house and fog signal should be established here, and it is recommended that an appropriation of $20,000 be made for the purpose.

—. *Rodman Point Shoal and Windmill Point Shoal, Pamlico River, North Carolina.*—For improving the navigation of Pamlico River and entrance at night into the port of Washington, N. C., lighted beacons were substituted for the buoys, respectively, marking these shoals. The Rodman Point Shoal light is a fixed white tubular-lantern light 10 feet above mean high water, on a pile painted black, standing in 8 feet of water. Windmill Point Shoal light is fixed red, shown from a tubular lantern 10 feet above mean high water, on a pile painted red, standing in 7 feet of water.

—. *Wreck Point, southeast of Cape Lookout, North Carolina.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

The establishment of a small light on this point would be of great assistance to a large number of vessels that seek a lee under Cape Lookout. A suitable structure can not be built at this isolated site for less than $5,000. It is recommended that an appropriation of that amount be made therefor.

—. *Beaufort Harbor, North Carolina.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

The harbor of Beaufort, N. C., is the only one of importance between Chesapeake Bay and Wilmington, N. C., a distance of some 200 miles. It is the natural outlet to the inland commerce of northern and middle North Carolina, and affords a refuge for vessels overtaken by storms on this exposed coast. A large number of coasting vessels from the North Carolina rivers and sounds pass out to sea by this harbor, thereby avoiding the dangerous navigation outside of capes Hatteras and Lookout.

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The annual commerce of this port is about $1,000,000. The depth of water at low tide is 13 feet 6 inches, and the width of the channel at the bar entrance is 1,000 feet. The inlet width is 7,000 feet, and there is good anchorage inside in 25 feet at low water. The channel across the bar is straight, and if properly marked by range lights it would be the safest and easiest harbor to enter between Cape Henry and Savannah. The estimated cost of establishing the necessary lights is $10,000. It is recommended that an appropriation of this amount be made therefor.

—. *Tobago day beacon, Middle Ground, Rappahannock River, Virginia.*—This middle ground has but 4 feet of water on it. A prominent mark there would be a valuable aid to the navigation of that part of the river. It is proposed to erect a screw-pile beacon at Tobago. This it is estimated will cost not to exceed $3,000. Recommendation is made that an appropriation of this amount be made therefor.

REPAIRS.

Repairs, more or less extensive, were made during the year at the following-named stations:

428. Cape Henry, Va.
435. Nansemond River, Va.
443. York Spit, Va.
452. Bells Rock, Va.
453. New Point Comfort, Va.
456. Bowlers Rock, Va.
466. Blakistone Island, Md.
470. Upper Cedar Point, Md.
473. Jones Point, Va.
482. Sharps Island, Md.
484. Bloody Point Bar, Md.
489. Craighill Channel (front), Md.
500. Fishing Battery, Md.
527, 528. Edenton Harbor Range, N. C.
529. Roanoke River, N. C.
531. Roanoke Marshes, N. C.
533. Hatteras Inlet, N. C.

LIGHT-SHIPS.

426. *Cape Charles light-vessel, No. 49, entrance to Chesapeake Bay, Virginia.*—This vessel was replaced upon her station July 5, 1893. She remained on her station during the year. In that time she received no repairs.

431. *Bush Bluff light-vessel, No. 46, entrance to Norfolk, Elizabeth River, Virginia.*—This vessel was, at the beginning of the year, relieved by light-vessel No. 49, at the Cape Charles station. On July 5 she was withdrawn, and after some repairs were made to her hull, she was on July 31 moored off Wolf Trap Shoal, Chesapeake Bay. On August 28, during a heavy gale, an explosion occurred in her port boiler from the collapsing of the steam chimney, killing the engineer in charge and one seaman. An investigation and report was made as to the cause of this explosion. The vessel was continued on her station, and the bell was used as a fog signal until December 10, when she was withdrawn. The starboard boiler was thoroughly overhauled and repaired, and she was replaced off Wolf Trap on March 16. The old light-house tender *Holly* was used as a relief light-vessel and is now stationed off Bush Bluff light-station. The schooner *Drift*, borrowed from the Coast and Geodetic Survey, was used during the year,

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part of the time as a relief light-vessel at Wolf Trap light-station and part of the time at Bush Bluff light-station.

—. *Cape Lookout Shoals light-vessel, North Carolina.*—The following recommendation, made in the Board's last two annual reports, is renewed:

Cape Lookout Shoals extend 8 miles beyond the point of the cape. There are dangerous breakers on the shoals 5 miles from the cape. When a vessel drawing more than 15 feet of water has made sufficient offing to just clear these shoals, she is 10 miles distant from the Cape Lookout light. Although this light is of the first order, shown from a tower 150 feet high, and should be seen a distance of 18 miles under favorable circumstances, it may happen during thick or hazy weather that a mariner may fail to see it in time to avoid that line of shoals. A light-ship of the improved model now constructed for use at exposed stations and provided with a steam fog signal, to cost $70,000, approximately, would be a valuable aid to navigation, if placed near the southern extremity of the shoals. It is therefore recommended that an appropriation of that amount be made therefor.

454. *Wolf Trap Shoal light-vessel, No. 46, Chesapeake Bay, Virginia.*—On July 31, 1893, this vessel relieved the tender *Holly*, then moored as a light-ship off this shoal, and remained on the station until December 10, 1893. From August 28 to December 10, 1893, her fog signal was disabled, and during that time the bell was used as a fog signal. On December 10, 1893, she was relieved by the schooner *Drift*, which had no steam fog signal, but only a bell struck by hand. Light-vessel No. 46, having been repaired, relieved the *Drift* on March 16, 1894, and was still on the station at the close of the fiscal year. This vessel was stationed off Wolf Trap about 7 months and 24 days.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

426. *Cape Charles light-vessel, No. 49, entrance to Chesapeake Bay, Virginia.*—This 12-inch steam whistle was in operation 175 hours during the year and consumed about 13¾ tons of coal.

428. *Cape Henry, entrance to Chesapeake Bay, Virginia.*—This first-class steam siren, in duplicate, was in operation some 202 hours during the year and consumed about 11¾ tons of coal.

454. *Wolf Trap Shoal light-vessel, No. 46, Chesapeake Bay, Virginia.*—The 12-inch steam whistle of this vessel was in operation during the 7 months and 24 days that she was on the station for about 39½ hours, during which she consumed about 6½ tons of coal.

DAY OR UNLIGHTED BEACONS.

Outer Diamond Shoal, off Cape Hatteras, North Carolina.—Skeleton iron frame, surmounted by a mast with crossed boards; erected May 27, 1894.

By authority of the Department, the old material comprised in the buildings at Thomas Point, Sandy Point, Greenbury Point, and Smith Point discontinued light-stations, was disposed of in June at public

sale. Some of these buildings had been included in the list of day marks. The old tower at Thomas Point fell on February 28, 1894. Of last year's list, the building at Clay Island has also fallen.

BUOYAGE.

The buoyage of this district is in good condition. All buoys were cared for by the tenders, with the exception of the stakes in Core Sound and the buoys inside the bar at Bogue Inlet. Small buoys were made for this inlet, and it is proposed to employ a local pilot to care for them. The stakes in Core Sound were renewed by contract under the supervision of the buoy master for North Carolina sounds.

DEPOTS.

Lazaretto Point, Baltimore, Md.—In September and October temporary quarters were fitted up for the custodian in the south end of the storehouse, as the rooms previously occupied by him in the north end of the building were needed for other purposes. Slight repairs also were made to the tin roofs of the wings of the storehouse and to the wharf and sea wall. The depot is in good condition. The shifting of the quarters of the custodian does not remove the necessity of a dwelling at the depot for his use, as set forth in the last four annual reports. The recommendation, made in the last four annual reports, with reference thereto is repeated.

Attention is invited to the necessity of providing a dwelling at this depot for the accommodation of the depot keeper and his family. Their quarters in the warehouse are unsuitable and uncomfortable, and even were the rooms not required for other purposes it would cost nearly as much to make them comfortably habitable as it would to build a new dwelling. About one-third of the space on the upper floor is reserved for the use of custom-house inspectors, and the large and increasing amount of work on hand in the district demands the use of all storage and shop room available. The depot keeper must be constantly on the spot, and can not live away from the premises. There is ample room on the Government tract for such a building as is required, and it can be built for $2,500. An appropriation of this amount is earnestly recommended.

Point Lookout, Md.—No repairs were made. The depot is in good condition. Injury is done to the wharf piles by vessels landing here for unofficial purposes, such as excursion and passenger steamers. The metal sheathing is chafed from the piles, and the latter are thus subjected to attack and destruction by the shipworm.

Portsmouth, Va.—The fences inclosing the premises, which were demolished by a storm during the preceding month, were rebuilt in November. During June some immediately necessary repairs were made to the wharf. Two hundred and ten running feet of outside rail, 6 by 12 inches, and 93 feet of railing, 4 by 12 inches, were scarfed, notched, and bolted. Some 67 pine and 10 oak piles were replaced by new.

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About 980 running feet of old joists were cut out and renewed. Some 8,140 square feet of new decking were spiked down. The ironwork of the crane was refitted to the decking, and its foundation was strengthened. The decayed wood of the tramway, 333 feet long, was removed and replaced by new, and the rails were relaid. Some temporary repairs were made at the same time to the coal and buoy sheds and to the custodian's dwelling. The old picket fence around the latter was taken down and replaced by a new one. Additional land adjoining the depot was purchased in 1892 in order to increase the wharf and storage facilities, but no benefit can be derived from the purchase in the absence of an appropriation to make the necessary improvements.

The following recommendation, made in the Board's last annual report, is renewed:

To make the repairs suggested and to extend the present wharf along the water front recently acquired by purchase will cost, it is estimated, $40,000, and an appropriation of that amount is recommended.

Washington, N. C.—No repairs were made during the year.

TENDERS.

The Jessamine.—The principal work of this steamer was in connection with the construction of new light-houses. She assisted in the transportation of materials for Cape Charles, Hog Island, Pages Rock, and Wolf Trap light-stations, making five trips to the first-named station. She assisted in making repairs at Mathias Point Shoal, Upper Cedar Point, Seven-Foot Knoll, Cutoff Channel, Smith Point, Laurel Point, Back River, Fort Carroll, and Sharps Island light-stations. She was used in arranging for the exhibition of red sectors in Cob Point Bar and Pooles Island lights; in taking borings at the proposed sites for Cedar Point and Lower Cedar Point light-houses, and in driving mooring piles at Wolf Trap foundation pier. In this work, and the numerous inspections to ascertain the condition of stations with reference to needed repairs, she steamed some 6,202 miles and consumed about 468 tons of coal. Her hull was cleaned and painted with germicide paint, her keel shoe was partly renewed, and small repairs were made to her hull, wheels, and coal bunkers. Repairs were made to the boiler, and she was docked and her hull was scraped and painted. Repairs were also made to her engine, and she was provided with a new rudder.

The Thistle.—This tug was mainly employed in towing scows laden with materials for the construction of, and in attendance upon working parties at, Cape Charles and Hog Island light-stations; in the transportation and setting up of the lens for Pages Rock light-station; in the repairs at Seven-Foot Knoll, Cutoff Channel, New Point Comfort, Craighill Channel, and Bloody Point Bar stations, and in inspecting the discontinued light-stations at Thomas Point, Greenbury Point, and

Fifth District.

Sandy Point. Her boiler, engine, rudder, and keel shoe were repaired. On a consumption of some 213 tons of coal she steamed about 6,605 miles.

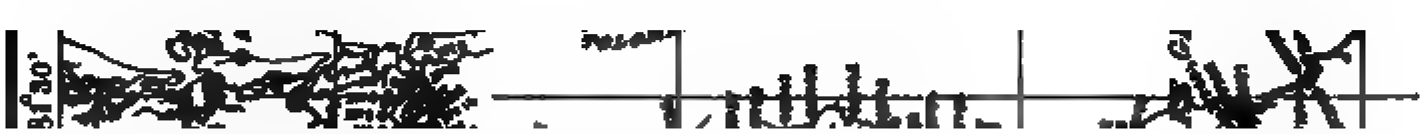
The Maple.—This steamer was in service during the whole year. She steamed some 18,520 miles and consumed about 1,425 tons of coal. Fires were hauled from under her boilers for 50 days; she worked 578 buoys and recovered 18 buoys; she visited 174 light-houses, delivered 229 tons of coal, 113 cords of wood, and left rations at 38 light-stations. The crew were employed in cleaning and painting buoys 70 days at buoy depots. She was on duty 17 days in the Sixth light-house district, and was eight days in towing barges from Baltimore to the new Cape Charles light-station, and 18 days in towing and attending to light-vessels.

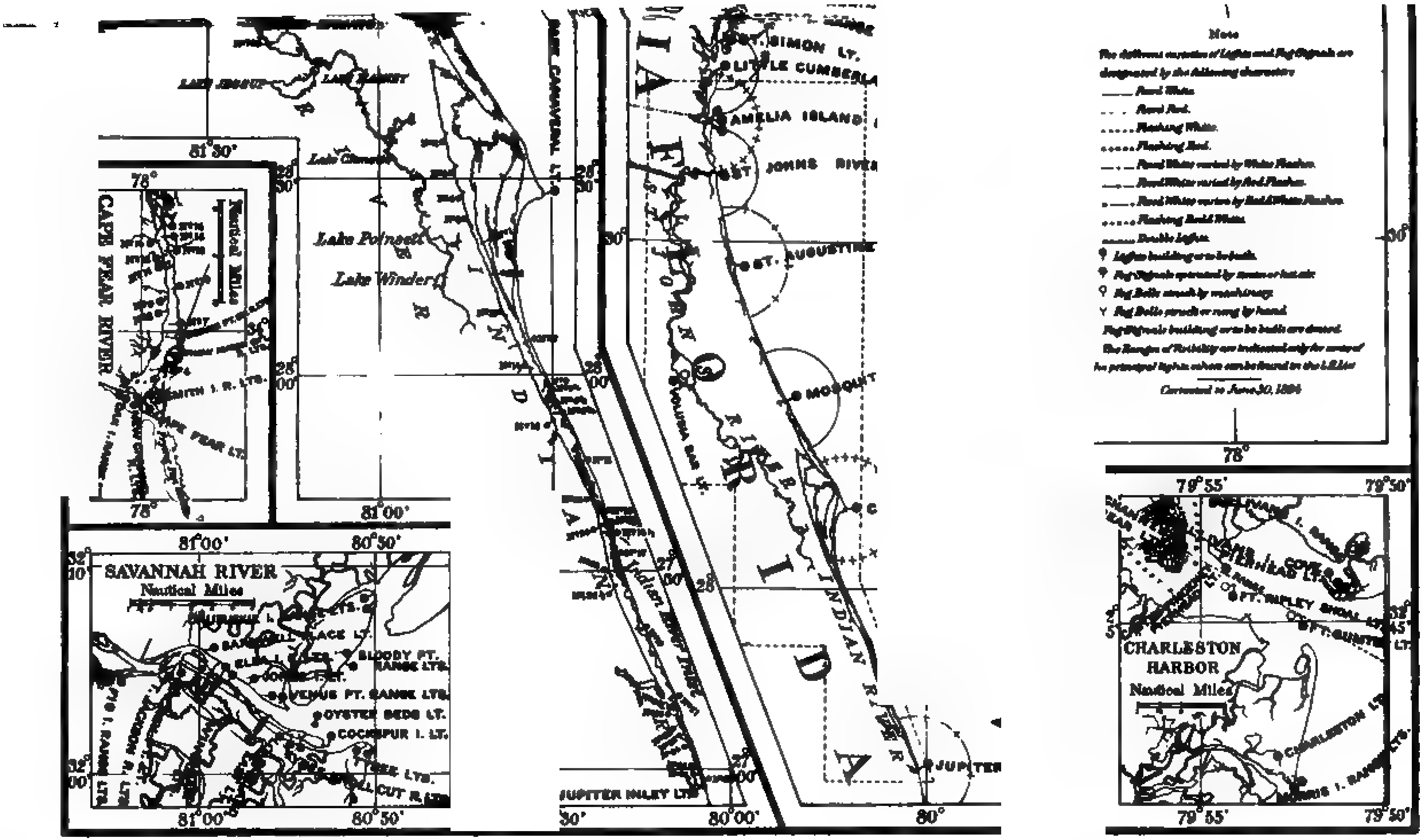
The Violet.—This steamer ran about 10,840 miles and consumed some 565 tons of coal. She worked 447 buoys, rebuilt 8 beacons, visited 150 lights, delivered 134 tons of coal and 63 cords of wood, delivered rations to 17 lights, and annual supplies to 20 lights in North Carolina, worked 31 days at the Portsmouth buoy depot cleaning and painting buoys, and was under repairs 71 days during the year. Her bottom was resheathed, and she is being generally overhauled and repaired. A new boiler is being built by contract, and will be placed in the vessel in August. A new rudder was also fitted, and a steam steerer was introduced. Upon the completion of this work the tender will be in first-class condition.

The Holly.—The vessel was put out of commission as a light-house tender, and was used as a relief light-vessel. She is now stationed off Bush Bluff, Virginia.

The Drift.—This schooner, borrowed from the Coast and Geodetic Survey, was used during parts of the year as a relief light-vessel at Bush Bluff and Wolf Trap light-stations. She is now laid up at the Portsmouth, Va., buoy depot.

The Bramble.—This vessel is used to supply gas to the beacons in Currituck Sound. As soon as her services can be spared it is proposed to lay her up for necessary repairs to her boiler and engine.





CAPE FEAR RIVER
Nautical Miles
SAVANNAH RIVER
Nautical Miles
CHARLESTON
HARBOR
Nautical Miles
ST. SIMON LT.
LITTLE CUMBERLA
AMELIA ISLAND
ST. JOHNS RIVER
ST. AUGUSTINE
MOSQUIT
VOLUSIA BAR LT.
INDIAN RIVER
JUPITER
JUPITER INLET LTS.
CAPE CANAVERAL LT.
Lake Poinsett
Lake Winder
SMITH I. R. LTS.
CAPE FEAR LT.
BLOODY PT. RANGE LTS.
VENUS PT. RANGE LTS.
OYSTER BEDS LT.
COCKSPUR I. LT.
FT. RIPLEY SHOAL LT.
CHARLESTON LT.
Note
Corrected to June 30, 1894

SIXTH DISTRICT.

The Sixth district extends from New River Inlet, North Carolina, to and including Jupiter Inlet, Florida, and includes all the aids to navigation within these limits on the coasts and in the bays, rivers, and harbors of North Carolina, South Carolina, Georgia, and Florida.

Inspector.—Commander M. R. S. Mackenzie, U. S. Navy.

Engineer.—Capt. Eric Bergland, Corps of Engineers, U. S. Army.

In this district there are—

Light-houses and beacon lights, including 140 post lights	203
Light-ships in position	3
Day or unlighted beacons	40
Fog signals operated by steam	2
Fog signals operated by clockwork	3
Whistling buoys in position	6
Bell buoys in position	16
Other buoys in position	300
Steamer *Wistaria*, buoy tender and for inspection and supply	1
Schooner *Pharos*, for construction and repair	1

It is necessary to state, before reporting in detail upon the work of the year, that this district, since the date of the last annual report, was visited by two storms of great severity. The first storm, in August, 1893, was preceded by cyclones off the coast on the 15th, 20th, and 23d, and the high seas engendered by them culminated on August 27–28 in a tide in the Sixth light-house district higher by 2 feet than any which has been recorded. The center of the storm crossed the coast line between Savannah and Charleston leaving desolation in its course and causing, it is estimated, a loss of more than 2,000 lives on the sea islands of South Carolina. Its force was very great as far south as Cape Canaveral, Florida, and as far north as Bull Bay on the South Carolina coast. On the Savannah River 5 barks were wrecked within a quarter of a mile of Tybee Knoll Cut front light, and in Charleston Harbor the wrecks were numerous. The light-house schooner *Pharos*, then at anchor in the bight at Cape Canaveral, narrowly escaped being driven ashore after parting the chains of 3 anchors which she had down at the time. The Wolf Island front beacon was overturned by the force of the sea. The Tybee beacon was undermined and overturned. The structures of the Tybee Knoll Cut front beacon, Elba Island front beacon, Bloody Point front beacon, Daufuskie Island front beacon and the wharf at the rear, Hilton Head front beacon, Paris Island front and rear beacons, Morris Island front beacons, and Fort Sumter and Bull Bay light-stations suffered seriously, small structures being carried some distance from their foundations and larger ones being injured by

Sixth District.

wind and tide. Boat landings and elevated wooden plank walks, of which there are some miles in this district, suffered especially, and almost all of them required such extensive repairs as to make it economical to rebuild them. This also was the case with the long wharves at Tybee Knoll Cut and Daufuskie Island light-stations, and at the buoy and supply depot at Charleston. The beacons on Morris Island, South Carolina, were swept away to sea so completely that nothing remained even of the sand hills on which they formerly stood.

The second storm, which occurred on October 11–13, crossed the coast line going inland near Georgetown, S. C., and proceeded northwardly, passing about 100 miles west of Washington, D. C. The principal injuries caused by it were at Georgetown and Oak Island light-stations, the tide rising to a height of several feet on the tower of the former and seriously injuring the dwelling and front beacon at the latter place; but, as before striking the coast it passed parallel with the land and near to it from Jupiter Inlet, Florida, to Georgetown, S. C., its effects were felt throughout the whole district.

The light-house schooner *Pharos* was caught in its center off the Florida coast between St. Augustine and Cape Canaveral, to which place she was bound with material and provisions. She lost her deck-load and naphtha launch and was injured in hull and rigging, but escaped shipwreck, although several large schooners were afterwards reported to have been lost in her vicinity.

It will thus be seen that the whole district has been twice subjected to unusual tests during this year. It is a matter of congratulation that it can be now reported as in good condition.

LIGHT-HOUSES.

—. *Cape Fear, seacoast of North Carolina.*—The following statement, which was made in the Board's last five annual reports, is renewed:

The shoals forming the continuation of this cape for about 18 miles to the southeast are dreaded by shipmasters only a little less than those at Cape Hatteras. At present a light-ship near the outer extremity of the shoals warns vessels of danger and gives them a good point of departure. This aid to navigation can not be dispensed with; but it is not sufficent to insure adequate protection to the large number of domestic and foreign vessels attracted to this point by the considerable and increasing trade of the neighboring port of Wilmington, N. C., because of the small area lighted by it, and because of its liability to be set adrift from its moorings during heavy storms, which is the very time when its light is most needed. The present Cape Fear light (Bald Head), on account of its inland position and want of height, does not cover the shoal, and therefore does not give sufficient warning to vessels when the light-ship may have drifted from her moorings. A first-order light-house built on the pitch of Cape Fear, with a radius of 18¼ miles of light, would be seen so far as to give timely warning, and the fact of being near enough to the coast to see it would be a sufficient indication that the observer should make a better offing. Other reasons for a first-order light-house here may be found in the better protection it would afford to the bight lying north of the cape, which has been left dark since

the discontinuance of Federal Point light-station in 1880. The proposed light would more than compensate for the one discontinued at Federal Point. It may be proper to add that there is no first-order light-house between Cape Lookout, North Carolina, and Cape Romain, South Carolina, a distance of about 170 nautical miles. Recent changes in the lighting of the entrance to the Cape Fear River have almost eliminated the Cape Fear light-house (Bald Head) as a harbor light. Its only use is that of a rear beacon to a stake light forming a range to guide up the river after crossing the bar. Upon the establishment of the proposed new light on the pitch of Cape Fear the old light might be discontinued, as the tower and the keeper's dwelling are antiquated and discreditable to the Light-House Establishment.

Urgent petitions have been presented to the Light-House Board by commercial and pilot associations of Wilmington, N. C., and by shipmasters trading to that port, which have had its careful consideration and approval.

It is estimated that a tower 150 feet high, with suitable oil room, keeper's dwellings, and outbuildings, on the pitch of Cape Fear, will cost $70,000, and it is recommended that this amount be appropriated therefor.

543. Cape Fear, entrance to Cape Fear River, North Carolina.—As it is proposed to discontinue this light upon the establishment of a first-order light-station on the pitch of Cape Fear, no expenditures were made at the station.

544, 545. Oak Island, mouth of Cape Fear River, North Carolina.—Changes in the channel at the entrance to the Cape Fear River have resulted in rendering these lights useless as a guide to vessels. It has accordingly been ordered that the station be discontinued on July 31, 1894. The illuminating apparatus and all other useful material will be taken down and stored to be utilized elsewhere.

550–564. Cape Fear post lights, Cape Fear River, North Carolina.—Lower Swash Channel post light No. 4 and Campbell Island post light No. 11 were rebuilt; the other post lights are in fair condition and are fairly well attended.

—. *Range lights for new dredged channels in the Cape Fear River, North Carolina.*—The following recommendation, made in the Board's last two annual reports, is renewed:

The Board recommended the discontinuance of ten of the present post lights in the upper part of the Cape Fear River, and the establishment of twenty-four new post lights, which, in connection with certain other ranges already established, would constitute a system of ranges to guide vessels from the Cape Fear entrance to Wilmington, N. C., through channels dredged to a depth of 20 feet at mean low water. As vessels are now carried by ranges one-half the distance between the entrance and Wilmington, and then left without further adequate guidance, the Board is of opinion that to complete the usefulness of the aids to navigation in the lower part of the river similar aids should be provided to guide them to their port of destination. It is estimated that this can be done at a cost not to exceed $3,105, and it is recommended that an appropriation of that amount be made for this purpose.

These channels have already been dredged to the depth of 18 feet.

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565. Georgetown, entrance to Pedee River, South Carolina.—A new boathouse and 700 running feet of new picket fence were built and various repairs were made.

569. Bull Bay, north end of Bull Island, South Carolina.—The foundation of the dwelling, injured by high water, was repaired and a wooden revetment, connected with sand fences, was built along its front, at a distance of 10 feet, for its further protection. The sea is making constant encroachments on the site, and strong protective work will be needed soon for its protection.

571, 572, 573. Charleston and Morris Island ranges, South Carolina.—The repairs made to the buildings were very extensive. A new boathouse, supported by sheathed piles, and 2,000 running feet of elevated plank walk were built, and temporary structures were put up to take the places of the front beacons which had been carried away by the storm. The front beacon of the Morris Island south range will last for a year or two, or until the progress of the improvement of the Swash Channel will make this range unnecessary.

574, 575, 576. Sullivans Island ranges, Charleston Harbor, South Carolina.—The bridge connecting the dwelling with the rear beacon, 250 feet long, was rebuilt upon piles sheathed with zinc. The color of the lights of the west range was changed from red to white and the color of the front light of the east range from white to red.

577. Fort Sumter, front beacon of Swash Channel range, Charleston Harbor, South Carolina.—The keeper's dwelling, on the berm of Fort Sumter, was carried away by the storm. The keeper and his family barely escaped with their lives. The force of the storm here overturned the 10-inch barbette guns mounted on the fort, and the coping stones of the parapet were washed away. A new dwelling was built.

578. St. Philips Church, rear beacon of Swash Channel range, South Carolina.—This beacon continues to work well. Permission to continue the occupation of the steeple in which it is situated for two years longer has been obtained from the vestry of the church.

—. *Inland Passage between Charleston, S. C., and Sullivans Island, South Carolina.*—This passage is about 4½ miles long, and the channel is tortuous, in some places narrow, and at night almost impracticable even for steamers. Two steam ferryboats carry passengers and freight between Charleston and Sullivans Island, and several steamers and numerous small sailing vessels trade to Santee River and Georgetown, S. C. It is proposed to establish six beacon lights for lighting this channel, at an estimated aggregate cost of $875, and to pay therefor from the general appropriation for repairs.

582. Hunting Island, entrance to St. Helena Sound, South Carolina.—Some 300 running feet of trestlework to connect the wharf with the high land was repaired with new caps, stringers, and decking, 150 feet

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of earthen causeway was raised above spring tide level, and 700 feet of new tramway track was laid.

584, 585. Hilton Head range, seacoast of South Carolina.—The keeper's dwelling and the front beacon were leveled up, six brick piers were built under the former, and its foundations otherwise strengthened. The outbuildings washed off by the tide, were rolled back and put in the position previously occupied by them; 300 running feet of sand fences were built and the bridges between the beacons and the fences at each were put in order.

586, 587. Paris Island range, Port Royal Sound, South Carolina.—The repairs here were extensive. New boathouse, etc., and boat landing were built and 1,500 running feet of new picket fence and 4,300 running feet of new high plank walk were built.

588, 589. Daufuskie Island range, seacoast of South Carolina.—The repairs here were extensive. The house was put into good condition and the 1,200 running feet of new wire fence and 1,000 feet of new picket fence were built. A new wharf, 375 feet long, supported by 68 sheathed piles, a boathouse, and 210 feet of elevated plank walk were built.

590, 591. Bloody Point range, Daufuskie Island, South Carolina.—The bridge betweeen the beacons and the fences of each were rebuilt. The boathouse, kitchen, storehouse, etc., were rolled from the places where the tide had carried them and they were reerected in their previous positions.

592, 593. Tybee light and beacon, Tybee Island, Georgia.—A substantial brick foundation was built for the front beacon, and the beacon was reerected and bolted to it with iron rods. The second assistant keeper's dwelling was almost entirely rebuilt, 1,140 running feet of new picket fence was constructed, and the station was generally overhauled and repaired.

595. Oyster Beds, Savannah River, Georgia.—The boat landing at the beacon was repaired, and a new one, with boathouse, was built near the Fort Pulaski wharf. The doors and windows of the beacon were replaced, a part of the masonry of the tower was cut out and built up again, and the structure was strengthened by tie-rods ending in wall plates.

596, 597. Tybee Knoll Cut range, Savannah River, Georgia.—Two large dredges collided with the dwelling, storehouse, and oil house during the storm of August, the line of plank walk was broken in many places by the passage over it of large lighters with their anchors dragging, and a drifting bark went through the wharf. Hence extensive repairs were made. A new storehouse, boathouse, and oil house were built, 4,174 running feet of new plank walk were constructed, and a long wharf at the station was put into good condition. Subsequent to the repairs of the wharf a bark, which had been driven ashore in

Sixth District.

the vicinity, was dug out, and in being hauled off it injured the wharf again. The owners of the bark made certain repairs, but they did not restore it entirely to its previous good condition.

598. Long Island East Beacon, Savannah River, Georgia.—A new lamp house was built. The beacon is in good condition.

600, 601. Venus Point range, Savannah River, South Carolina.—The platform at the rear beacon was rebuilt, the boat landing and 300 running feet of trestlework approach were renewed, 270 running feet of high plank walk and 5,900 feet of low plank walk were constructed, and a new storehouse, etc., was built. Various repairs were made.

602. Jones Island, Savannah River, South Carolina.—A new lamp house was built and the boat landing was repaired.

604, 605. Elba Island range, Savannah River, Georgia.—The boat house was rebuilt, a new boat landing and 470 running feet of trestle and elevated plank walk were constructed.

609. Barnwell Place, Savannah River, South Carolina.—A new lamp house was built and the landing repaired.

611, 612. Fort Jackson range, Savannah River, Georgia.—The brick oil house, which had been broken into by burglars, was repaired, and 205 feet of trestlework and boat landing were restored.

615. St. Catherines Sound, seacoast of Georgia.—In accordance with the act approved March 3, 1893, for the establishment of a fourth-order light-house on this sound, a site was selected on St. Catherines Island, Georgia, and an unsuccessful effort was made to purchase the land required for it at a reasonable price. Proceedings in condemnation were then instituted to obtain title, but were suspended upon application of the owner of the land, who asked that an examination of Ossabaw Island, Georgia, be made, to determine if a site could not be found there, which, while serving the public purposes as well as the site selected on St. Catherines Island, would be less objectionable to him. The examination was made, but proved futile. The owner then demanded $50,000 for the site originally selected. This price being prohibitive, proceedings in condemnation were renewed. Pending the settlement of title no work has been done.

618, 619. Wolf Island range, entrance to Doboy Sound, Georgia.—The front beacon, which was overturned by the sea during an August storm, was reerected on a substantial brick foundation, to which it was anchored by iron rods. Some 600 running feet of plank walk were built and various repairs were made.

621. St. Simon beacon, Georgia.—The proceedings in condemnation to procure title to the site selected for this beacon were begun in 1893, and have dragged their slow length along to the point where an award has been made by the court having jurisdiction. The title has not yet, however, been approved, as is required, by the U. S. Attorney-General. Hence no work has yet been done at the site.

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—. *The inside passage from Savannah, Ga., to Fernandina, Fla.*—In its last five annual reports the Board recommended that it be empowered to erect and maintain twenty-five post lights, in order to facilitate the navigation of the inland passage from Savannah to Fernandina, at an estimated cost of $4,000, and that the appropriation for lighting of rivers be increased by that amount to permit of the establishment and maintenance of these lights. This recommendation is renewed.

623, 624. Amelia Island range, Fernandina entrance, Florida.—The permanent lights of this range had been discontinued, because the channel through which they were intended to guide vessels shifted so much and so often as to make them worse than useless. Hence light wooden skeleton structures which could be easily moved to accommodate them to changes in the channel were substituted for them. These give satisfaction.

—. *Mount Cornelia, mouth of St. Johns River, Florida.*—The following recommendation, which was made in the Board's last five annual reports, is renewed:

> The present light-house at the mouth of St. Johns River, Florida, is of the third order, and for years there have been complaints that it was inefficient as a seacoast light, while as a harbor light the new jetty channel will soon require the establishment of a range to which this structure, on account of location, can not be adapted. It has a small base and stands on marshy ground, and can not be increased sufficiently in height to make it a good seacoast light. A site peculiarly adapted to the erection of a light-house is found near the mouth of the river, on its north side, on Mount Cornelia, which has an extreme elevation of 62 feet above mean sea level, and on which a good foundation with sufficient area for a modern light-station could he had at an elevation of 50 feet above mean sea level. A first-order light-house, with focal plane 150 feet above its base, erected at this point, would have a focal plane 200 feet above mean sea level and a 20-mile radius of light. This would intersect with the adjacent seacoast light to the southward, situated at St. Augustine, Fla., better than the present St. Johns River light does, and would practically cover the area now lighted by the adjacent seacoast light to the northward, situated on Amelia Island, Florida, as its area of light would intersect with that of the next most northerly light at Little Cumberland Island, Georgia, and almost touch that of St. Simon, Georgia. The proposed light might thus be made to take the place of two or even three third-order light-houses, all old and unsightly structures, and provide a light second only on the Atlantic coast to that at the Highlands of Navesink, N. J.

It is recommended that an appropriation of $125,000 be made for the establishment of this light.

631–701 and 703–712, each inclusive. St. Johns River post lights, Florida.—The beacons have been put in good order.

715. Cape Canaveral, seacoast of Florida.—On July 1, 1893, the working party which was sent to move this light-station to a safe site, under the provisions of an item in the sundry civil appropriation act, approved August 30, 1890, making an appropriation of $80,000 for the purpose, was landed at Cape Canaveral. By October, quarters, storehouses, a substantial wharf on sheathed piles, a tramway 2 miles long, and a temporary beacon with focal plane of 57 feet, for service during

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the period of removal and reerection of the permanent light were built and on October 25 the taking down of the lantern of the iron tower was begun. The tower was taken down, hauled to the new site, reerected on the concrete foundation which had in the meanwhile been prepared for it, and on June 7, 1894, it was ready for relighting. The first-order light will be shown from its new position, and the temporary fourth-order light discontinued, on July 25, 1894. The new site was cleared and graded. Some 800 tons of material were transported from Charleston and received and handled at the station. One keeper's dwelling has been removed and partly reerected; the removal of the other has been begun, and preparations have been made for inclosing and paving the new site. It is expected that the work will be completed in about three months.

716–748. Indian River post lights, Florida.—Some changes are required and some beacons are down, but all lights are shown. It is found to be difficult to get reasonable bids for making required repairs. The lights, with some exceptions, are not well attended.

—. *Reimbursement of light-keepers for personal losses sustained during the cyclones of August 27–28, 1893.*—A number of keepers of light-houses, the officers and crew of a light-vessel, and the keeper of a buoy depot sustained more or less heavy personal losses when the stations where they were employed were wrecked. Many of them displayed much devotion to the service and incurred great personal danger.

The Board therefore brought these matters to the attention of the honorable Secretary of the Treasury, and he, in letters of November 9 and 16, 1893, and January 29, 1894, to the Speaker of the House of Representatives, transmitted the sworn statements of each keeper as to his losses, indorsed by Commander M. R. S. Mackenzie, U. S. Navy, inspector of the Sixth light-house district, and recommended that provision be made by Congress for the reimbursement of the losses sustained by these keepers. The losses as shown in these statements amount to $2,399.13. Recommendation is made that an appropriation of that amount be made for the reimbursement of losses sustained by the light-house employés in the Sixth light-house district.

Similar losses were sustained by light-keepers in the Eighth light-house district during the hurricane of October 1, 1893. Statements of the losses they sustained, duly approved and indorsed by the light-house inspector, were sent to the Speaker of the House of Representatives by the Treasury Department in its letters of January 29, March 7, and April 3, 1894, with recommendation that reimbursement be made. The sum of these losses, as stated, amounts to $2,603.62. Recommendation is made that an appropriation of this amount be made for the reimbursement of the losses sustained by light-house employés in the Eighth light-house district.

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REPAIRS.

At each of the following-named stations repairs of greater or less extent were made during the year:

566. Sampit River, S. C.
594. Cockspur Island, Ga.
613, 614. Fig Island range, Ga.
616, 617. Sapelo light and beacon, Ga.
622. Little Cumberland Island, Ga.
625, 626. Tiger Island north range, Fla.
630. St. Johns River, Fla.
702. Volusia Bar, Fla.
713. St. Augustine, Fla.
749. Jupiter Inlet, Fla.

LIGHT-SHIPS.

542. Frying-Pan Shoals light-vessel No. 53, off Cape Fear, North Carolina.—This is one of the new iron vessels which has steam power for self-propulsion, and has a hawse pipe through the stem. This vessel went safely through both the August and October cyclones. In the latter she lost her boats and had her whole deck house badly wrecked. A new boat was sent to her as soon as practicable. The Rattlesnake Shoal light-vessel No. 34, having been driven ashore in the August cyclone the relief vessel No. 29 was put on that station, so that there was no relief available for the Frying-Pan Shoals station. For some weeks after the October cyclone, the weather near Frying-Pan Shoals was very bad and the officers and crew went through a trying experience. As soon as light-vessel No. 34 was got off the beach and repaired, she was sent to the Frying-Pan Shoals station, and light-vessel No. 53 was brought in, her bottom cleaned and painted, and a new deck house was built.

570. Rattlesnake Shoal light-vessel No. 34, off Charleston, S. C.—This vessel parted both cables during the cyclone of August, 1893, and was driven ashore on Long Island Beach, South Carolina. The officers and crew are entitled to great credit for their excellent behavior under these trying circumstances. Relief light-vessel No. 29 was put on Rattlesnake Shoal light-station. Light-vessel No. 34 was hauled off from the beach under contract, and was thoroughly repaired. Light-vessel No. 34 not only went through the August cyclone, but she was on the beach during the October cyclone and suffered severe thumping. It cost but $1,800 to put her in good repair. This shows something of her strength. On May 31, 1894, light-vessel No. 29 was brought in from the Rattlesnake Shoal station, and light-vessel No. 34 was placed on the new Charleston station.

583. Martins Industry light-vessel No. 1, off Port Royal entrance, South Carolina.—This vessel parted her heavy moorings in the August cyclone and dragged her second anchor until she was, to all appearances of the sea, in the breakers. She lost her boats. The master had three ribs broken. The mate, as soon as the storm broke, worked the vessel back as nearly as possible to her proper position. The weather not being

clear enough to see marks, and the buoys being dragged out of position, he found when the weather cleared that she was still out of position. He then got under way again and worked the ship up to her position. When visited by the tender the light-vessel was found to be almost exactly where she should be. In the October cyclone this vessel was filled even full to the rail by one sea that boarded her.

—. *Relief light-vessel No. 29.*—This light-vessel was, in August, 1893, put on Rattlesnake Shoal light-station to take the place of light-vessel No. 34, which was stranded during the August cyclone. On May 31, 1894, light-vessel No. 29 was relieved and was brought in and laid up for future use as a relief light-vessel.

DAY OR UNLIGHTED BEACONS.

There are in this district 40 day or unlighted beacons.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

542. Frying-Pan Shoals light-vessel No. 53, North Carolina.—This vessel was off her station for repairs in January and February, and there was no fog during the other ten months of the year, and therefore the signal has not been in use throughout the year.

583. Martins Industry light-vessel No. 1, South Carolina.—This 12-inch steam whistle was in operation about 26 hours, and consumed some 2 tons of coal.

BUOYAGE.

The buoyage of the district is in fair order.

DEPOTS.

Castle Pinckney, Charleston Harbor, South Carolina.—The custodian's dwelling was repaired. The stone breakwater around dwelling and storehouse was raised and strengthened. The wharf was repaired, and a house for the gas tank and a boathouse were built.

The following extract from the joint report of the inspector and engineer of the Sixth light-house district, dated September 12, 1893, describes the destruction of the old depot and shows the necessity and gives the cost of a new depot:

The effect of the storm upon the depot was, in brief, to undermine the foundations of the storehouse, tear off its weatherboarding, lay open its contents to the action of the winds and sea, and to scatter its stores in every direction and for long distances. On the wharf, 60 by 200 feet, a great part of the decking was torn loose from the joists, and in some measure the joists were broken, and in places even the caps were parted from the piles, with the result of dropping into the water below sinkers, anchors, and buoys. Boats stored on the land in rear of the fort, high above the ground, were washed away and lost, and even the keeper's dwelling, which was built several feet above the general level of the site, was in serious danger from the waves.

As the storm did great injury to many light-stations, carried two light-vessels from their moorings, and drifted many buoys from their positions, there was a great

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demand made upon the depot for stores and supplies at the very time that its defects and weakness had deprived the district of its reserves.

The lesson taught by all this is that our depots should be so built as to be able to resist the greatest storms, and so located as to permit of the construction of solid buildings on firm foundations. That such structures can be built on the water fronts of the district is evidenced by the present condition of the only two granite piers in Charleston, and of the granite sea wall along the east front of the Battery, which are as solid as before the storm. But such structures can not be built at Castle Pinckney without so great an expenditure for foundations as would make them cost much more than similar buildings on a proper site with the cost of site added to them, because the island upon which Castle Pinckney stands is nothing but a mud flat, and was used by the Light-House Establishment only because, while an urgent necessity existed for a depot, no funds were available for the purchase of a proper site, and the War Department permitted the occupation of the Castle Pinckney reservation without charge.

The building of a fort at this point, at great cost for foundation, was justified by its position in the system of defense of Charleston Harbor, but has been abandoned by the War Department. It is supported on piles, but has sunk, and with it the island in the vicinity, until the surface of the latter is below high-water level, and this subsidence has continued more or less since the depot was established in 1879, necessitating the building up, from time to time, of the surface with sand taken from the fort, and a system of wooden platforms, with riprap stone protection, of dwelling and storehouses, which is in itself a source of expense in maintenance. Besides the great exposure of the wharf structure to easterly winds and seas, it has been found necessary on two occasions to extend it farther into Folly Island Channel, in consequence of the shoaling up at its head, and it is probable that further extension will be required in the future from the same cause.

A minor unsuitableness or inconvenience, but a very real one, comes from its separation by nearly a mile of water from the nearest part of Charleston, over which there is no public ferry or means of communication.

For all these reasons it seems fitting that a better depot should be provided for this district, and if a change is to be made no more favorable time for it, pecuniarily, than the present is likely to be found, because the old depot now requires repairs estimated at $6,814, of which $4,500 might be saved if it is determined to abandon it, and because of the dismantled and broken condition of the wharves on the water front of Charleston, which, before permanent repairs are made to them, could probably be purchased at lower prices than will rule again for some years.

If a change is approved by the Board, and in our opinion a change must come sooner or later, we would respectfully recommend that adequate provision be made for a first-class depot, all the structures of which should be of the best quality and of brick, iron, and granite or concrete. This would demand a site with a water front of 180 feet, to allow for two wharves, 40 feet wide, with a slip between of 100 feet, and a depth inland of, say, 150 feet, for the convenient location of offices, storehouse, coal shed, oil and paint house, and lamp shop, and such a piece of property could probably be purchased *now* for between $25,000 and $30,000.

The following approximate estimate is submitted, viz:

Two twin docks, partly on iron-screw and partly on iron-sleeve piles, with iron superstructure excepting decking, each to have 8,000 square feet of surface, at $25,000	$50,000
One iron coal shed, 3,200 square feet of surface, with automatic loading and unloading railway, complete, with cars	12,000
One iron boat shed for spare boats	800
One brick and iron fireproof oil and paint house	1,000

Sixth District.

One brick depot-keeper's dwelling	$4,000
One brick lamp shop of 1,200 square feet floor surface, with tools and furniture	5,000
One brick storehouse, with offices on second story, 40 feet by 80 feet in plan, furnished	20,000
One sea wall 350 feet long, of granite or concrete, at $50 per linear foot	17,500
	110,300
Site, say	30,000
Add 10 per cent for contingencies	14,030
Total	154,330

It is estimated that the legal expenses may bring the total cost of the depot up to $155,000, and it is again recommended, as it was last year, that an appropriation of this amount be made for the purchase of a site for a depot at or near one of the dock piers at Charleston, S. C., and for the erection thereon of suitable buildings.

TENDERS.

The Wistaria.—This steamer replaced and relieved 431 buoys, painted 361, repaired 29, and recovered 10 buoys, and did 27 days' work at depot. She transported the inspector quarterly to inspect light-stations and light-ships, and delivered to light-ships some 120 tons of coal and 12 cords of wood. She steamed some 17,707 miles, with an expenditure of about 967 tons of coal and 3½ cords of wood. She was 77 days and 17 hours in motion, 243 days and 14 hours under steam, and 121 days and 10 hours without fires under her boiler. The bottom was thoroughly repaired, and a new condenser was put in. For this purpose the tender was out of the district from October 4 to December 16. During the August cyclone the *Wistaria* was lying in the custom-house dock, it being thought better to take the risk of slight damage from chafing to that of being driven ashore, so that her services would not be available when most needed. She suffered slight damage, the port guards being badly wrecked. It is due to the skill and zeal of the officers and crew that she was not very seriously damaged. They were for this commended in a letter addressed to them by the honorable the Secretary of the Treasury, and their pay was doubled for September, 1893, during which month they had suffered so great hardship and done such heavy duty.

The Pharos.—This schooner was employed on repair and construction duty. During July and August she was engaged at Cape Canaveral light-station, Florida. After losing anchors and chains and narrowly escaping shipwreck in the cyclone of August, she put back to Charleston to refit. During September she was engaged in making temporary repairs, urgently needed, at Morris Island, Tybee, Tybee Knoll Cut, Venus Point, Sapelo, and Wolf Island light-stations. During October

Sixth District.

she loaded for Cape Canaveral, and although caught in the cyclone of this month, with the resulting loss of the deck load and naphtha launch, and injury to hull and rigging, she completed her voyage, discharged the remainder of her cargo, and returned to Charleston. She was hauled out on the marine railway in the fall, when leaks were stopped, the metal on the bottom was patched, sails, hawse pipe, bulwarks, galley, and boats were repaired, and the naphtha launch was replaced. Then she made extensive repairs to Paris Island light-station, South Carolina. During February and March she was engaged in making repairs at Daufuskie Island and Hilton Head light-stations, South Carolina, and in loading materials for repairs of stations on the Savannah River, Georgia. During April and May she was engaged in repairing Tybee Knoll Cut, Venus Point, Oyster Beds, and Tybee light-stations. During June she repaired Wolf Island, Sapelo Island, and Hunting Island light-stations. Then she returned to Charleston to be herself repaired, after a year of continued and arduous service. She will be calked, have her bottom coppered, her rails, rudder, and hatches repaired, her standing and running rigging overhauled, and be painted.

SEVENTH DISTRICT.

The Seventh district extends from just south of Jupiter Inlet, Florida, to the mouth of the Perdido River, Florida, and includes all aids to navigation on the Atlantic and Gulf coasts of Florida within these limits.

Inspector.—Commander William B. Newman, U. S. Navy.

Engineer.—Maj. James B. Quinn, Corps of Engineers, U. S. Army.

There are in this district—

Light-houses and lighted beacons	34
Day or unlighted beacons	36
Whistling buoys in position	3
Bell buoys in position	5
Other buoys in position	251
Steamer *Laurel*, buoy tender and for supply and inspection	1
Steamer *Arbutus*, for construction and repair in the Seventh and Eighth districts.	1

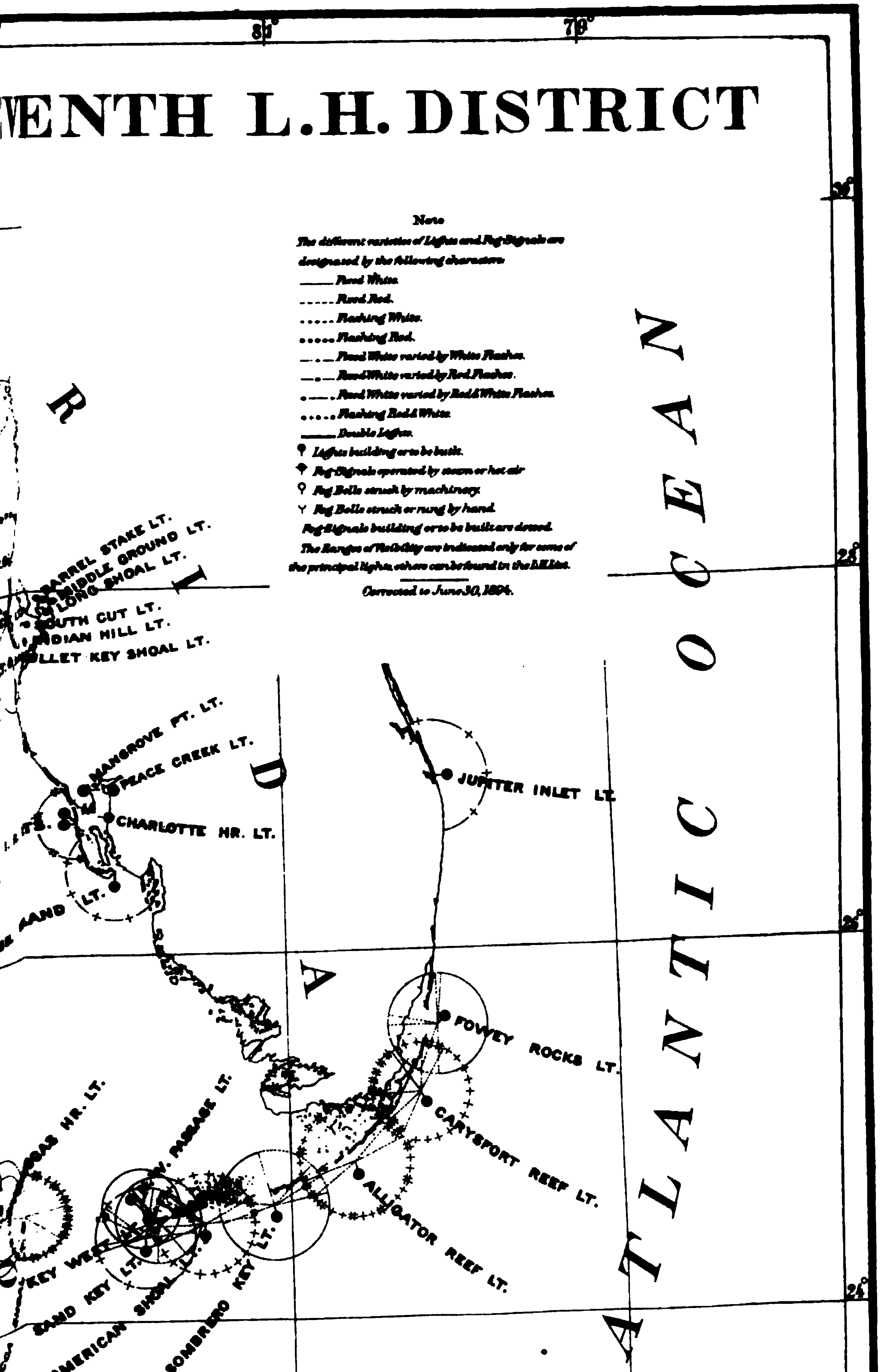
LIGHT-HOUSES.

—. *Hillsboro Inlet, off Hillsboro Point, between Jupiter Inlet and Fowey Rocks lights, Atlantic coast of Florida.*—The following recommendation, which was made in the last nine annual reports of the Board, is renewed, with the recommendation that $90,000 be appropriated for this purpose:

The establishment of a light at or near Hillsboro Point, Florida, would be of great assistance to all vessels navigating these waters. Steamers bound southward, after making Jupiter Inlet light, hug the reef very closely to avoid the current. The dangerous reef making out from Hillsboro Inlet compels them to give it a wide berth and to go out into the Gulf Stream. Vessels coming across from the Bahama Banks would be able to verify their position if a light were placed here; a difficult matter in case they fail to make Jupiter Inlet. The establishment of this light would complete the system of lights on the Florida reefs. The Board therefore renews the recommendation that $90,000 be appropriated for this purpose.

—. *Biscayne Bay, at the southern end of the peninsula of Florida, Gulf of Mexico.*—This sheet of navigable salt water is about 40 miles long, with an average width of some 8 miles. There is no light on it, as the private light formerly maintained from January to June of each year has been discontinued. The light, it is claimed, was not only of great service to the vessels navigating the bay, but also to vessels seeking to enter from the outside through either the Cape Florida or the Bear Cut Channel, as it could be seen outside through each of these channels. It is estimated that a proper light could be established here at a cost not to exceed $1,000. Recommendation is made that an appropriation of this amount be made therefor.

755. Sand Key, near Key West, Gulf of Mexico, Florida.—Iron frames are being made for putting up the red sectors at this station.



ENTH L.H. DISTRICT
Note
The different varieties of Lights and Fog Signals are designated by the following characters
Fixed White.
Fixed Red.
Flashing White.
Flashing Red.
Fixed White varied by White Flashes.
Fixed White varied by Red Flashes.
Fixed White varied by Red & White Flashes.
Flashing Red & White.
Double Lights.
Lights building or to be built.
Fog Signals operated by steam or hot air
Fog Bells struck by machinery.
Fog Bells struck or rung by hand.
Fog Signals building or to be built are dotted.
The Ranges of Visibility are indicated only for some of the principal lights, others can be found in the L.H. List.
Corrected to June 30, 1894.
ATLANTIC OCEAN
R
I
D
A
BARREL STAKE LT.
MIDDLE GROUND LT.
LONG SHOAL LT.
SOUTH CUT LT.
INDIAN HILL LT.
LLET KEY SHOAL LT.
MANGROVE PT. LT.
PEACE CREEK LT.
CHARLOTTE HR. LT.
JUPITER INLET LT.
FOWEY ROCKS LT.
CARYSFORT REEF LT.
ALLIGATOR REEF LT.
SOMBRERO KEY LT.
AMERICAN SHOAL LT.
SAND KEY LT.
KEY WEST
N.W. PASSAGE LT.
HR. LT.
81°
79°
28°
26°
24°

Seventh District.

756. *Key West, Key West Island, Gulf of Mexico, Florida.*—Under the appropriation act approved March 3, 1893, plans and specifications were prepared for increasing the height of the tower, bids were received for the metal work, and project for completion of the work submitted. The work will be done as soon as practicable. Various repairs were made.

760. *Tortugas Harbor, on a bastion of Fort Jefferson, Garden Key, one of Tortugas group, Florida.*—The northerly red sector in this light was corrected so that the southerly edge bears NE. by E. ¼ E.

761. *Sanibel Island, on the east end of Sanibel Island, near the entrance to San Carlos Harbor and port of Punta Rassa, Fla.*—Contract was made for building an oil house. Minor repairs were made.

762. *Gasparilla Island, near the southern end of Gasparilla Island, entrance to Charlotte Harbor, Florida.*—Contract was made for building an oil house.

767. *Egmont Key, entrance to Tampa Bay, Florida.*—Some 500 running feet of plank walk were laid, and various minor repairs were made. Repairs to the Egmont Key wharf were also made during the year. They consisted in driving 26 foundation piles under the wharf, 11 fender piles, and a 4-pile cluster at end of wharf. A contract was made for building an oil house. A red sector was fitted in this light, and on December 30, 1893, its characteristic was changed from fixed white to fixed white with a fixed red sector.

The following recommendation, which was made in the Board's last annual report, is renewed:

> A new dwelling is needed for the assistant light-keeper. The Board estimates that it can be built for not exceeding $4,000, and it is recommended that an appropriation of this amount be made for that purpose.

This is an important light. At certain points the seaward red sector is not visible at a sufficient distance. It is proposed to increase the power of this light from the fourth order to the third order, to remedy this difficulty. It is estimated that it will cost not to exceed $6,000 to do this, and it is recommended that an appropriation of this amount be made therefor.

—. *Tampa Bay beacons, Florida.*—The following is a list of the beacons erected during the year for lighting the entrance to Tampa Bay and the channel through the bay to Port Tampa. The beacons will all be ready for lighting as soon as the lanterns are furnished and put in place, with the exception of the four beacons in Hillsboro Bay, of which only the woodwork has been framed, and which will probably be completed early in the ensuing year.

North Channel.—A conical day beacon to take the place of buoy No. 2 in the North Channel.

Southwest Channel.—A cylindrical day beacon to take the place of buoy No. 2 in Southwest Channel.

Mullet Key Shoal.—A white-lighted beacon off Mullet Key to replace buoy No. 3.

Seventh District.

Indian Hill.—A white-lighted beacon near Indian Hill in range with buoys Nos. 1 and 6 and the channel buoys to the northward.

Wreck of steamer Cool.—A conical day beacon marking the wreck of the steamer *Cool.*

South Cut.—A red-lighted beacon 450 feet east by north from old beacon No. 6.

North Cut.—A red-lighted beacon 300 feet east of old beacon No. 10.

Codfish Point.—A day beacon off Codfish Point, in Hillsboro Bay.

Long Shoal.—A white-lighted beacon on Long Shoal, in Hillsboro Bay.

Middle Ground.—A red-lighted beacon, Middle Ground, Hillsboro Bay.

Depot Key.—A white-lighted beacon off Depot Key, in Hillsboro Bay.

NOTE.—An additional appropriation of $1,670.81 was made by the sundry civil appropriation act approved on August 18, 1894, which will make it possible to erect all the aids to navigation which the Board proposed to establish in Tampa Bay. The work will be finished at an early day.

775. *Anclote Keys, on the south end of the most southerly of the Anclote keys, Florida.*—A contract was made for building an oil house. Minor repairs were made.

778. *Crooked River, Florida.*—On July 31, 1888, $40,000 was appropriated for the erection of a light-house on the mainland to westward of Crooked River, in Franklin County, Fla. The land for the site was selected and a deed for 12.2 acres, with a tracing showing the location and an abstract of title, was sent on September 19, 1889, to the U. S. attorney for examination. The deed was found to be insufficient, and condemnation proceedings were instituted. In July, 1891, the United States court-house was destroyed by fire, and all the papers in the case were burned. The papers were at once duplicated, and the title to this site was approved on August 22, 1892, by the Attorney-General of the United States. Section lines were located and borings were made to determine the character of the foundation soil. Plans and specifications have been prepared, and bids have been invited for the complete erection of the light-station.

779. *Cape St. George, on Cape St. George, near St. George Sound, Florida.*—Contract has been made for building an oil house. Various repairs were made.

—. *Carrabelle River, St. George Sound, Gulf of Mexico, Florida.*—Carrabelle is a town of about 1,500 inhabitants. Its principal business is lumber and canning oysters. It has recently become the terminus of a railroad from Tallahassee, and is then connected by steamer through St. George Sound, with Apalachicola. Several tugs are engaged in the lumber business and a fleet of small schooners and sloops in the oyster trade. Carrabelle River is crooked and shallow and it has but 6½ feet of water at low tide. This makes much night work necessary in taking advantage of the tides. The river entrance

is difficult at night, as it is nearly at right angles with the general trend of the stream, and hence lights are needed to facilitate its navigation. Owing to the peculiar formation of the bar it is proposed to establish two lighted beacons in range to aid in keeping the channel over the bar, and it is further proposed to establish another lighted beacon on a small island near the town to aid vessels in going up the river. It is estimated that these three beacons will cost not to exceed $1,000, and it is proposed to pay for the establishment of them from the general appropriation for repairs of light-houses, which provides for the erection of beacons under such circumstances.

780. Apalachicola Bay, front beacon, on the dredged channel leading into Apalachicola Bay, Florida.—This beacon was erected in 1887, and paid for from the special appropriation for Apalachicola Bay range lights, Florida. In August, 1890, the beacon was destroyed by a tug; it was rebuilt, and destroyed again by the same tug and a tow of barges in November, 1891; it was restored the second time, and was again knocked down by a tug in February, 1894. A single-pile beacon was established in its place by local interested parties. From an examination of the foundation soil it is evident that it would be imprudent to erect an ordinary pile beacon. It is therefore recommended that a more substantial structure be placed there, on a pile and concrete foundation with a cylindrical concrete superstructure. It is estimated that the construction of such a beacon will cost not exceeding $7,000, and it is recommended that an appropriation of this amount be made therefor.

782. Cape San Blas, near the south point of Cape San Blas, Florida.—Borings were made at the new site for this station to determine the character of the foundation soil. An effort was made to determine the geographical position for the new light, but it was unsuccessful on account of the removal of the Coast Survey monuments. Condemnation proceedings to obtain title to the new site have been instituted, but thus far without result. Contract has been made for the building of an oil house.

—. *St. Joseph Point, St. Joseph Bay, Gulf coast of Florida.*—The following recommendation, which was made in the Board's annual reports for the last six years, is renewed:

The fishing fleet on this coast is large. A southerly gale is calculated to drive these vessels upon a lee shore. The only harbor of refuge for some 60 miles is St. Joseph Bay. This is easily accessible in the daytime, but at night it is difficult of entrance without a light. The Board is decidedly of opinion that it would be largely to the interests of the fishing fleet in particular, and the commerce and navigation of the Florida coast in general. that this light should be established. It is estimated that it can be done for $25,000. A bill for this purpose was favorably reported upon recently by the Senate Committee on Commerce, and the Senate inserted the item in the sundry civil appropriation bill, but as it failed of enactment the recommendation is renewed.

Seventh District.

783. *Pensacola, near Fort Barrancas, Pensacola Bay, Florida.*—A shed was built in which to store empty oil boxes; walks and steps were rebuilt and a steel picket fence erected around buildings. Various minor repairs were made.

788. *Fort Barrancas rear range, on the bluff in the rear of the front light, Florida.*—The wood foundation and substructure of the beacon was replaced with substantial brick piers, upon which heavy corner posts were placed and securely anchored to the piers. Various repairs were made.

—. *Deer Point, entrance to Santa Rosa Sound, Pensacola Bay, Florida.*—The following recommendation made in the Board's last annual report is renewed:

> The establishment of a beacon light here, at a cost not to exceed $1,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount be appropriated.

REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

750. Fowey Rocks, Fla.
751. Carysfort Reef, Fla.
753. Sombrero Key, Fla.
759. Dry Tortugas, Fla.
785. Fort McRae (front), Fla.

DAY OR UNLIGHTED BEACONS.

Two of the four beacons marking the dredged cuts from Tampa Bay to Old Tampa Bay were destroyed by collision of tows. The remaining two being in insecure condition, new beacons of five piles each were put down to replace them.

Florida Reef beacons—Some of these beacons are down and all require extensive repairs. They are of importance as day marks, and are of great assistance in navigating along the Florida Reef, and they should be restored so as to serve their original purpose. It is estimated that it will cost not to exceed $10,000 to put them in proper repair, and it is recommended that this amount be appropriated therefor.

BUOYAGE.

The buoyage of the district is in good condition. New buoys were placed as follows: In Tampa Bay and entrance a buoy was placed to mark a small shoal near the entrance buoy, north channel, on which the English steamer *Palatine* grounded; one to mark a 17-foot rocky lump in the bay near the dredged cuts leading to Old Tampa Bay, and one in the southwest channel to mark the south point of Egmont Key Shoal. In Key West harbor, at the northeast entrance, three buoys were placed to mark a new channel, and a buoy, marked "Jetty," in white letters, to mark the northwest end of the submerged jetty. In

Seventh District.

St. Joseph Bay, Florida, three buoys were placed to mark the main ship channel.

The following buoys were discontinued: Key West Harbor, Florida, main ship channel, channel rock having been removed by blasting, the buoy marking it has been discontinued. Northwest entrance: The new channel having been buoyed, 2 buoys in the former channel were discontinued. In all, 10 new buoys were placed and 3 discontinued, leaving an increase in the buoyage of the district of 7 buoys. Six buoys have gone adrift and 1 has been sunk; 4 were recovered, making the loss for the year 2 buoys, 1 of them the oldest whistling buoy in the district.

DEPOTS.

Tortugas Harbor, Fort Jefferson, Gulf of Mexico, Florida.—The blacksmith shop and buoy shed are in good condition.

Key West buoy depot and coal shed, Gulf of Mexico, Florida.—This depot remains much the same as it was when reported last year. It requires extensive repairs to make it useable, and to save the wharf and coal shed from complete destruction. This being a sort of halfway station in this long district, it is a very important point from which to work buoys and to send supplies in both directions, and at which light-house steam tenders can take in a supply of coal to make runs among the reef light-houses and with which to return to the main land. It is estimated that this wharf and coal shed can be put in proper repair for not exceeding $10,000, and it is recommended that an appropriation of this amount be made therefor.

Egmont Key, entrance to Tampa Bay, Gulf of Mexico, Florida.—The coal and buoy shed are in good condition. A complete set of new leaders was put on the building and two new cisterns were added. Temporary repairs were made to the wharf; the wharf was raised up level, and new fender piles were driven. This is the only light-house depot in the Seventh light-house district where fresh water can be obtained except by purchase. The buoyage of the west coast of Florida is worked from this depot, and it is highly necessary that the wharf be made a permanent structure. It is now merely a temporary structure and it will require extensive and expensive repairs if retained, owing to the ravages of the teredo and limnoria. It is estimated that it will cost not to exceed $10,000 to make this a permanent structure, and it is recommended that an appropriation of this amount be made therefor.

Pensacola, Fla.—This depot is in good condition, but it has no wharf. The Navy coal wharf is a wreck; the fender and supporting piles are nearly all gone and the next southerly gale it is feared will finish it. The wharf can not be satisfactorily or economically repaired. Wharfage facilities here are exceedingly necessary. It is estimated that a new wharf can be built at a cost of not more than

$15,000, and it is recommended that an appropriation of that amount be made therefor.

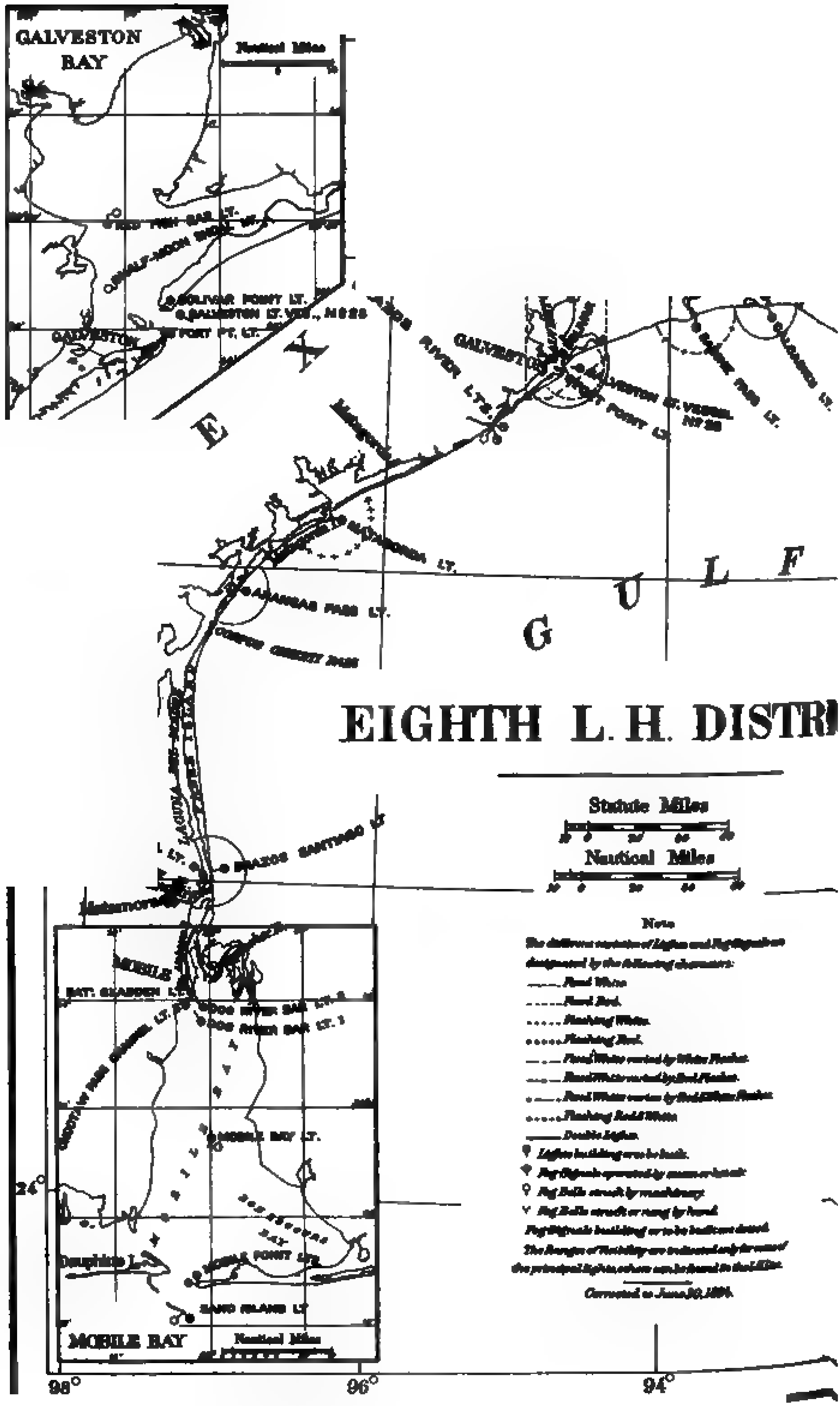
At this depot fresh water has been so scarce on account of dry weather that none for the use of the tender could be spared by the yard authorities for over six months, necessitating the purchase of the city water at Pensacola. In every case the change from rain water to that from driven well was felt by those using it. At this depot there were manufactured during the year 319 third-class and 42 second-class shackles complete; 22 first-class and 50 second-class shackles were repaired and fitted with new pins and keys; 175 first-class and second-class pins were refitted; 359 second-class and 355 third-class keys were made; 67 buoys were more or less extensively patched; 46 buoys were bushed, and two buoys had new eyes put in. All the tools, scaling hammers, chain cutters, etc., needed by the tender in buoy work were made. The tender's smokestack was repaired, and many other repairs to the tender and for the light-stations were made by the depot force.

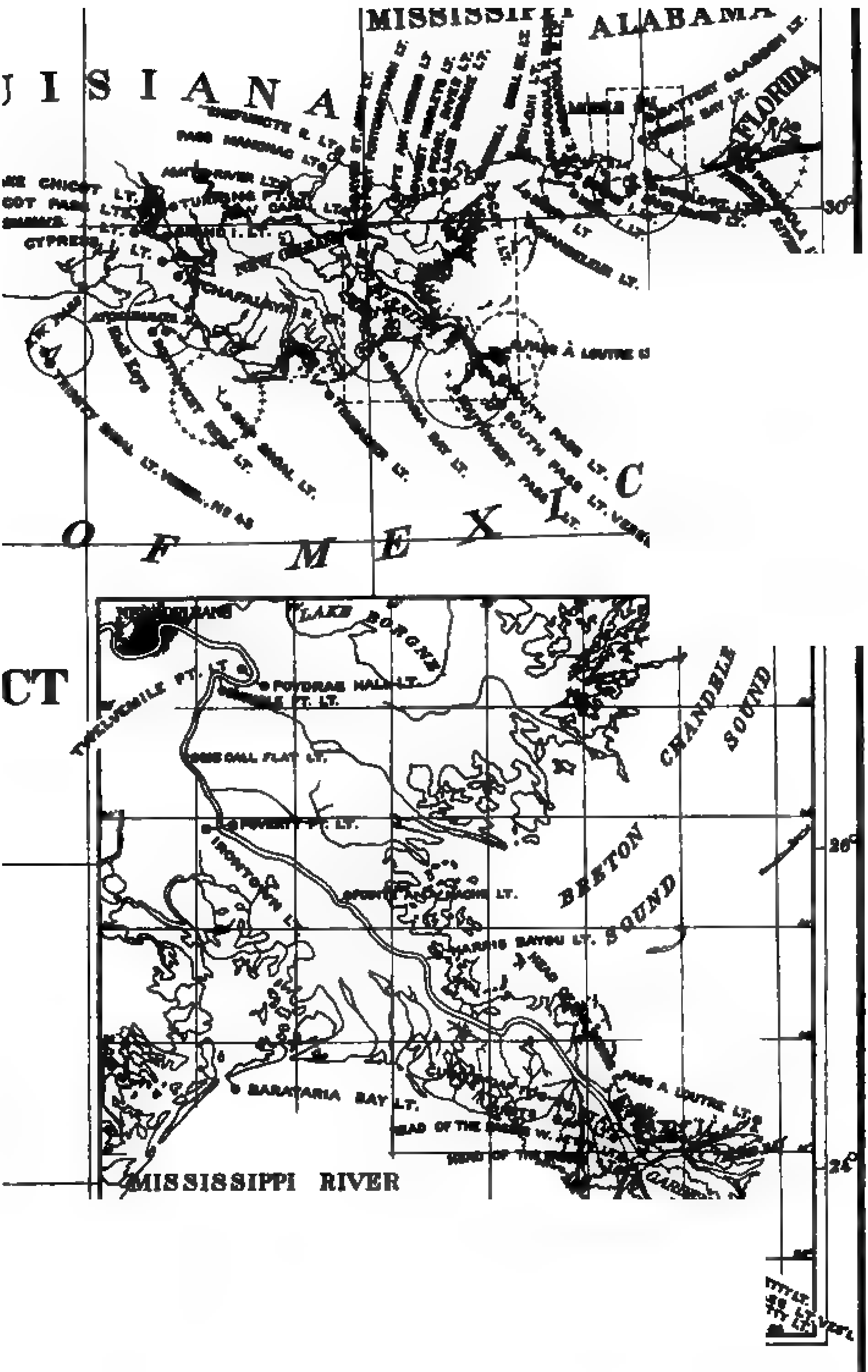
TENDERS.

The Laurel.—This steamer was constantly employed at the regular inspection, supply, and buoy work of the district. Her crew cleaned and painted 250 buoys, changed 240 buoys, and landed 25 cords of wood and 64 rations at light-stations. She made 69 inspection trips, and her crew worked 75 days in the different depots. The crew bushed 37 buoys and patched 8 while away from the depot shop. She was under steam 255 days and fires were hauled 110 days. In performing this duty she steamed 7,463 nautical miles and consumed, for all purposes, 454 tons of bituminous coal. The hull of the vessel is in fair condition; some spots of dry rot were cut out and replaced by the depot force. The upper deck was recanvased while the boiler was being repaired. A new mainsail and mainstaysail were supplied. The smokestack was extensively repaired. The boiler required considerable patching. The starboard flue, where joining the flue sheet, and the flue sheet were extensively patched; since then it has been necessary to soft patch the lower flue on the port side; both the lower flues are too thin to hard patch satisfactorily.

New tender.—The *Laurel* is so old and so frail that it is quite evident that she has nearly survived her usefulness. If she can be kept in commission until a new tender is built and ready for service it will be as much as can reasonably be expected. It is estimated that a tender can be built specially fitted for service in the Gulf of Mexico and its tributaries for not exceeding $80,000, and it is recommended that an appropriation of this amount be made therefor.

9


GALVESTON BAY
Nautical Miles
RED FISH BAR LT.
HALF-MOON SHOAL LT.
BOLIVAR POINT LT.
GALVESTON
GALVESTON
GALVESTON LT. VESSEL No 28
BOLIVAR POINT LT.
SABINE PASS LT.
E
X
G
U
L
F
ARANSAS PASS LT.
CORPUS CHRISTI PASS
EIGHTH L. H. DISTR
Statute Miles
Nautical Miles
BRAZOS SANTIAGO LT.
Note
Fixed White.
Fixed Red.
Flashing White.
Flashing Red.
Double Lights.
MOBILE
MOBILE BAY LT.
MOBILE POINT LT.
SAND ISLAND LT.
Dauphine I.
MOBILE BAY
Nautical Miles
24°
98°
96°
94°


MISSISSIPPI
ALABAMA
FLORIDA
UISIANA
CHANDELEUR LT.
PASS À LOUTRE LT.
SOUTH PASS LT.
SOUTHWEST PASS LT.
BARATARIA BAY LT.
O F M E X
C
CT
LAKE BORGNE
POYDRAS HALL LT.
TWELVEMILE PT. LT.
POVERTY PT. LT.
CHANDELEUR SOUND
BRETON SOUND
MARIS BAYOU LT.
BARATARIA BAY LT.
PASS A LOUTRE LT.
MISSISSIPPI RIVER
30°
29°

EIGHTH DISTRICT.

The Eighth district extends from the mouth of the Perdido River, the boundary between Florida and Alabama, to the Rio Grande, the southwestern boundary of Texas, and includes all aids to navigation on the Gulf coast of the United States within these limits, together with those in lakes Borgne, Pontchartrain, Maurepas, Grand Lake, and Lake Chicot, and those on the Mississippi River below New Orleans, La.

Inspector.—Commander Dennis W. Mullan, U. S. Navy, to February 28, 1894; Commander Joseph B. Coghlan, U. S. Navy, from February 28, 1894.

Engineer.—Maj. James B. Quinn, Corps of Engineers, U. S. Army.

In this district there are—

Light-houses and beacon lights (including seventeen post lights on the Mississippi River, Grand Lake, and Lake Chicot)	66
Light ships in position	2
Day or unlighted beacons	13
Fog signal operated by steam	1
Fog signals operated by clockwork	11
Whistling buoys in position	4
Bell buoys in position	1
Other buoys in position	96
Steamer *Pansy*, buoy tender, and for supply and inspection	1
Steamer *Arbutus*, for construction and repair in the Seventh and Eighth districts	1

LIGHT-HOUSES.

792. *Sand Island, off Mobile Point, Gulf of Mexico, Alabama.*—A plank walk, 376 feet long, was built from the dwelling to the wharf and various repairs were made. The sea is rapidly encroaching upon the site of this light-house tower and threatens to undermine it soon. A jetty, built between the ruins of the former tower and the shore in the vicinity of the present tower, has not prevented the erosion of the site.

793. *Mobile Point, east side of channel into Mobile Bay, Alabama.*—Some 572 feet of plank walk was built leading from the main light to the beacon. A plank walk, with railing from the dwelling to the main light, and other walks leading to the outbuildings were put down, and various repairs were made.

797. *Dog River Bar and Choctaw Pass channel ranges, beacon No. 2, on Dog River Bar, Alabama.*—A new lamp house was built, the beacon was straightened, and minor repairs were made.

799. *Battery Gladden, below the mouth of Mobile River, Alabama.*—Two wharves were built, one 5 feet wide and 160 feet long, and the other 3 feet wide and 240 feet long, and various repairs were made.

Eighth District.

—. *The ship channel, Mobile Bay, Alabama.*—The establishment of light-stations here, at a cost not exceeding $60,000, was authorized by the act approved February 15, 1893.

NOTE.—An appropriation of $30,000 was made for this purpose by the sundry civil appropriation act approved on August 18, 1894, and it was further provided "that the total cost of establishing said additional lights, under a contract which is hereby authorized, shall not exceed $60,000." Plans for the establishment of the needed lights are now being prepared. It is estimated that the additional $30,000, originally suggested as needed, will be required. Recommendation is therefore made that an appropriation of this amount be made therefor.

800. *Horn Island, eastern end of Horn Island, Gulf of Mexico, Mississippi.*—A wharf 156 feet long, and plank walks leading from the dwelling to the outbuildings were rebuilt. Repairs were made to the boat-house. Various other repairs were made.

801. *Round Island, off Pascagoula, Gulf of Mexico, Mississippi.*—A new iron fence around the buildings, and a wharf 300 feet long, terminating in a T-head, were constructed. Repairs were made to dwellings, outbuildings, walks, and the like.

802. *Pascagoula River front beacon, at the entrance to Pascagoula River, Mississippi.*—This beacon, which was damaged by the severe storm of October 1, 1893, was thoroughly repaired.

803. *Pascagoula River rear beacon, at the entrance to Pascagoula River, Mississippi.*—This beacon, also damaged by the severe storm of October 1, 1893, was thoroughly repaired.

804. *East Pascagoula River, mouth of East Pascagoula River, Mississippi.*—Extensive repairs were made at this station. Some 480 tons of ballast, consisting of rock, oyster shells, and sand were placed on the light-house reservation, and in front and rear of the breakwater.

805. *Ship Island, Gulf of Mexico, Mississippi.*—Some 281 cubic yards of sand were placed around the dwelling, which was put in good repair.

806. *Biloxi, western entrance to Biloxi Bay, Mississippi.*—This station was seriously damaged by the storm of October 1, 1893, when the breakwater was destroyed. It is proposed to put in a new breakwater at the earliest opportunity.

807. *Cat Island, western end of Cat Island, Mississippi.*—This station, which was damaged by the storm of October 1, 18 [illegible]

808. *Merrill Shell Bank, between Cat Island, S* [illegible] *Grand Island, Mississippi.*—This station, which [illegible] storm of October 1, 1893, was put in repair.

809. *Lake Borgne, entrance to Lake Borgne, Miss* [illegible] was blown off in the storm of October 1, 1893, an [illegible] wharf were carried away. The station was put in repair.

810. *Pearl River, on the east bank of the river, about seven-eighths of a mile below the railroad bridge, Mississippi Sound, Mississippi.*—An appro-

Eighth District.

priation of $250 was made by the act approved on March 2, 1889, for the establishment of a light at this point. Continuous but unsuccessful effort has been made to obtain title to a site on which a proper structure could be erected. The difficulty is that the owner can not give such a title as the Government can accept. The legal costs of condemning a site would probably exceed the appropriation. The Board therefore recommends that Pearl River be included in the general appropriation for lighting rivers, when under its provisions a site for the lights can be leased and the light can then at once be established.

811. *West Rigolets, eastern entrance to Lake Pontchartrain, Louisiana.*—A new wharf was built; a platform was built, and a plank walk was laid from the dwelling to the breakwater. Various repairs were made.

812. *Point aux Herbes, Lake Pontchartrain, Louisiana.*—Two small platforms, with steps, were built, 200 feet of plank walk were laid leading from the dwelling to the outbuildings and breakwater, and various repairs were made.

815. *New Canal, Lake Pontchartrain, Louisiana.*—A walk of plank and piling was built leading from the dwelling to and around the warehouse; some grading was done around the buildings, and minor repairs were made to the dwelling and breakwater.

Fogs are quite common at certain portions of the year at this point, and at such times navigation is practically stopped until the shore can be seen. Owing to the little variation in the shore line, a thin fog stops vessels. Fog signals would enable vessels to keep on their way at such times. A fog bell struck by machinery is deemed sufficient. It is estimated that one could be installed here at a cost not to exceed $1,200, and it is recommended that an appropriation of that amount be made therefor.

817. *Pass Manchac, between Lake Maurepas and Lake Pontchartrain, Louisiana.*—It is recommended, for the foregoing reasons given in the case of New Canal, that a fog bell to be struck by machinery be established here. It is estimated that this can be done for not exceeding $1,200, and it is recommended that an appropriation of that amount be made therefor.

818. *Amite River, entrance from Lake Maurepas, Louisiana.*—It is recommended, for the foregoing reasons given in the case of New Canal, that a fog bell to be struck by machinery be established here. It is estimated that this can be done for not exceeding $1,200, and it is recommended that an appropriation of this amount be made therefor.

819. *Chandeleur, near northern extremity of Chandeleur Island, Louisiana.*—This station was nearly destroyed by the storm which visited this locality October 1, 1893. It has not been deemed advisable to restore the light on its present site, owing to the encroachments of the sea.

Eighth District.

The light has become of special importance to the fleets of vessels which visit Ship Island anchorage, as well as to those vessels seeking the entrance to Mississippi Sound, and it is believed that the needs of commerce warrant the advance of the light to the third order, with suitable increase in height of light above mean high water. The cost of changing the site and reconstruction is estimated at $35,000.

NOTE.—An appropriation of $35,000 was made in the sundry civil appropriation act approved on August 18, 1894. Plans for the work are now in course of preparation.

821. *South Pass East Jetty, mouth of the Mississippi River, Louisiana.*—A boathouse was built; two plank walks, one 375 feet long and one 600 feet long, were put down. Various repairs were made. These were made necessary by the damage done by the storm of October 1, 1893.

822. *South Pass West Jetty, mouth of the Mississippi River, Louisiana.*—A new plank walk was built, and extensive repairs were made to the beacon.

823. *South Pass front beacon, mouth of the Mississippi River, Louisiana.*—The foundation timbers were renewed, and slight repairs were made to the beacon.

824. *South Pass rear beacon, mouth of the Mississippi River, Louisiana.*—This station, which was also damaged by the storm of October 1, 1893, was put into repair.

825. *Southwest Pass, mouth of the Mississippi River, Louisiana.*—On May 22, 1894, this station was partially destroyed by fire, and the light was extinguished. Immediate measures were taken for the restoration of the light. A lantern was obtained from the South Pass light-station and put in place, new plate glass was supplied, temporary quarters for the keepers were constructed, and on June 15 the station was again lighted. The damage to this tower is remarkable, and was not to be expected. The oil was stored in another building or the destruction of the tower might have been complete.

The dwelling at this station was burned out, and since there is danger to be apprehended from like occurrence if this form of dwelling is restored, it is deemed essential to safety and the comfort of the keepers to have the dwellings detached from the light. It is estimated that proper dwellings can be erected at this station for not exceeding $10,000, and it is recommended that an appropriation of this amount be made therefor.

826. *Head of the Passes, on Deer Island, mouth of the Mississippi River, Louisiana.*—The oil house was moved, outhouses were built, and a plank walk leading from the dwelling to the boathouse was put down. Various repairs were made.

827. *Head of the Passes West Jetty, upper entrance to South Pass, Mississippi River, Louisiana.*—The lantern for this new beacon was put in place, and on October 20, 1893, the light was exhibited for the first time.

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830. *Cubits Gap fog-signal station, at Cubits Gap, Mississippi River, Louisiana.*—The land is being cut away rapidly just above the station. The signal tower is already endangered. Various repairs were made.

839. *Barataria Bay, entrance to Barataria Bay, Louisiana.*—The keeper's dwelling, outbuildings, and cisterns were thoroughly overhauled and repaired; 360 feet of iron fence was placed around the dwelling; 425 feet of 5-foot wharf, and 570 feet of plank walk were constructed, and repairs were made to the boathouse, oil house, and minor repairs to the tower. This station was almost completely wrecked in the storm of October 1, 1893, and the repairs and extensions were difficult to make, as it is in an out-of-the-way place. It is proposed to move the tower to the cover face of the fort as soon as it can be conveniently done, as the land in the vicinity of the tower is being very rapidly washed away.

840. *Timbalier, entrance to Timbalier Bay, Gulf of Mexico, Louisiana.*—This light was undermined by the scouring of the channel, and on the morning of January 23, 1894, it canted over. The illuminating apparatus was saved in a damaged condition. An attempt was made to take the dismantled tower to pieces and save it, but owing to the inability of the light-house tender to approach near enough to the wreck, and the urgent need of her services elsewhere, the work was discontinued. The difficulty and expense of doing the work was such that it was decided that the wreck should be abandoned. A temporary square pyramidal structure was erected to show a fixed lantern light 30 feet above mean high water, on the north side of Timbalier Island, about 1½ miles west of the east end, but on the west side of Grand Pass, entrance to Timbalier Bay, Louisiana. A temporary dwelling for the keeper was also erected 30 feet from the beacon. The new beacon bears SW. ½ W. distant one-half nautical mile from the wreck of Timbalier light-house. This light was exhibited for the first time on March 20, 1894. The Board at its session May 7, 1894, decided that the requirements of navigation were not such as to justify the reestablishment of Timbalier light-station, but instead to use a lens-lantern light, similar to the one now in use at Head of the Passes, Louisiana, upon the beacon lately erected and used for the tubular-lantern light now displayed, which can be done at an approximate cost of $250. Early measures will be taken for establishing such a light.

—. *Oyster Bayou, Gulf of Mexico, Louisiana.*—This bayou opens into the Gulf of Mexico, and is the entrance inland for all small craft engaged in the oyster, fish, and other industries. The vessels, something over 300 in number, supplying the four oyster packers at Morgan City, pass through Oyster Bayou. Vessels frequently attempt to make the bayou at night, and lacking a light to indicate the entrance, sometimes sail 5 or 6 miles beyond it before discovering their mistake. It is therefore proposed that a light-house be placed here.

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Oyster Bayou is a recognized inside channel. If vessels did not pass through it, they would have to go around Pointe a Fer and the Southwest Reef light-house to reach Morgan City, thus taking an outside route very dangerous for small vessels. The mouth of the bayou is exposed to the severe storms of the gulf, which, at times, bank the water up to a height of 6 or 7 feet above the ordinary level and sweep over the place in violent waves. Hence it will be necessary to place the light-house on iron piles in order to raise it above the reach of storm waves. The station should be established on the point formerly occupied by the private light maintained there by certain oyster packers of Morgan City. It should consist of a keeper's dwelling, from the top of which should be shown a white light from a lens lantern. It is estimated that this could be built at a cost not to exceed $5,000. Recommendation is made that an appropriation of this amount be made therefor.

841. Ship Shoal, Gulf of Mexico, Louisiana.—A constant scouring is taking place around the foundation of the light-house which is liable at any time to undermine the structure, but no perceptible settling of the light has yet been observed. A quantity of rock deposited at Fort Pickens and intended for use at this station was examined and measured with a view to its removal to Ship Shoal light-station for the protection of its foundation.

852. Calcasieu, in marsh at the entrance to Calcasieu River, on the west bank of Calcasieu Pass, Louisiana.—A contract was made for building an oil house at this station. Various minor repairs were made.

—. Mermenteau River light-station, near the mouth of the Mermenteau River, Gulf of Mexico, Louisiana.—The following statement, made in the Board's last annual report, is repeated:

> The establishment of a light here, at a cost not to exceed $7,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board again recommends that the amount named be appropriated.

—. Sabine Pass jetty light, entrance to Sabine River, Louisiana.—The east jetty projects into the Gulf a long distance and is particularly dangerous to vessels drawing less than 12 feet. A large concrete block has been built on the outer end of this jetty, and with little additional cost, and without interfering with engineering operations, a lens lantern could be installed here which would be of great benefit to commerce. It is estimated that it would cost not to exceed $500, and it is recommended that an appropriation of this amount be made therefor.

855. Bolivar Point, on Bolivar Point, north side of the entrance to Galveston Bay, Texas.—Repairs at this station consisted in thoroughly overhauling and repairing the keeper's dwelling, removing the kitchen to one side and connecting it with the dwelling, and building new brick piers under the dwelling, two chimneys, and a cistern. A brick walk

Eighth District.

was laid from the dwelling to the light-house, and a plank walk from the dwelling to the gate. The fence was repaired and all new work was painted.

The Board has under consideration a plan for improving the aids to navigation at the entrance to Galveston Harbor which provides that Bolivar Point light, which is now a second-order fixed white light, be changed to a five-second flash light, and that it shall form a range with the new light which it is proposed to establish at the entrance to the harbor. This plan is dealt with more specifically in the next paragraph under the head of Galveston Harbor.

—. *Galveston Harbor, Texas.*—It is essential, owing to changes now taking place in the entrance to Galveston Harbor, that some alterations be made in the method of lighting now in use. The Bolivar Point light is already some distance inland, and its value as an off-shore light is, in consequence, greatly impaired, particularly during smoky or foggy weather, when the light is often invisible and does not afford any assistance to vessels approaching the entrance. It is essential that there be some efficient fog signal near the outer ends of the jetties to prevent vessels colliding with them in foggy or hazy weather. It is therefore proposed that a new light of the third order, with a steam or hot-air fog signal, be established near the outer end of the south jetty. It is further proposed, as before stated, that the character of the Bolivar Point light be changed from a second-order fixed white light to a five-second flash light upon the establishment of the new light, and also that the position of the Galveston light-ship be changed from time to time until the full effect of the north jetty shall be determined. The contemplated changes and new constructions as described, it is estimated, would cost not to exceed $35,000. Recommendation is made that an appropriation of this amount be made for carrying this plan into effect.

859. Brazos River, Texas.—The site originally selected for this light-station was located on the banks of the canal near the mouth of the Brazos River, and borings were made in January, 1894, to determine the character of the foundation soil. It was alleged that the construction of light buildings thereon would conflict with the rights of the company owning the canal. Hence condemnation proceedings, which had been begun, were suspended and the subject of a new location is now under consideration. The plans for the light-station have been prepared. The exact location of the range beacon and fog bell has not been determined, and can not be until the jetties are sufficiently advanced in construction to enable the beacon and fog signal to be placed near the outer end of the south jetty.

861. Aransas Pass, on a low island, inside of Aransas Pass, Texas.—Contract was made for the erection of an oil house. Various minor repairs were made.

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863. *Point Isabel, Texas.*—The purchase of the site of this light-house is now pending, and it is probable that title will be vested in the United States and the light reestablished during the ensuing year.

NOTE.—The purchase has at last been consummated. The title to the site is now in the Government. The light will be shown at an early day.

—. *Reimbursement of light-keepers for losses sustained during the hurricane of October 1, 1893.*—Statement of these losses, to the amount of $2,603.62, approved and recommended by the inspector of the Eighth light-house district, were sent by the Secretary of the Treasury to the Speaker of the House of Representatives in his letters of March 7 and April 3, 1894, with recommendation that reimbursement be made. The Board recommends that an appropriation of this amount be made therefor.

REPAIRS.

At each of the following-named stations, repairs, more or less extensive, were made during the year:

795. Mobile Bay, Ala.
796. Dog River Bar beacon, No. 1, Ala.
798. Choctaw Pass Channel, rear, beacon No. 3, Ala.
813. Port Pontchartrain, La.
816. Chefuncte River, La.
817. Pass Manchac, La.
818. Amite River, La.
820. Pass à Loutre, La.
856. Fort Point, Tex.
858. Red Fish Bar, Tex.

LIGHT-SHIPS.

851. *Trinity Shoal light-vessel, No. 43, moored 1 1-2 miles to the northward of Trinity Shoal, Gulf of Mexico, Louisiana.*—No repairs were made to this light-vessel during the year. On account of the commerce formerly benefited by this vessel having fallen off to almost nothing, and none but small vessels now navigating these waters, it has been concluded to discontinue the light-vessel and substitute a bell buoy on the southern edge of Trinity Shoal, which will answer all present requirements. The fog-signal bell now in operation at South Pass East Jetty is not sufficiently powerful for the needs of the station, and Congressional authority has been asked to moor the vessel off South Pass, Louisiana, where a greater benefit to the commerce of this pass would be afforded. Before mooring the vessel in her new position it is contemplated to thoroughly overhaul her. Extensive repairs are required to her boilers. The main rigging will be renewed and fore rigging overhauled and renewed where necessary. New bilge keel bolts will be required. A shelter roof will be built over the after deck to catch water, in order to avoid a great consumption of coal in condensing water, as at present. The entire deck leaks badly and needs calking, and her bottom needs to be remetaled in places. A new set of lamps and reflectors were supplied.

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NOTE.—Authority was given in the sundry civil appropriation act approved August 18, 1894, for the establishment of a light-vessel off the South Pass of the Mississippi River, provided that the Trinity Shoal light-vessel be first discontinued. The Trinity Shoal light-vessel was discontinued on August 15, 1894, and light-vessel No. 43 will be established off South Pass as soon as she is put into proper condition. She is now being repaired.

854. Galveston light-vessel, No. 28, inside of Galveston Bar, Gulf of Mexico, Texas.—The vessel was calked outside, from the water's edge up, the entire decks and a portion of the rail stanchions. A new cross-piece for the riding bit was supplied. In May this vessel was moved about 1¼ nautical miles to the eastward of its old position, which increases the efficiency of the vessel in foggy weather by having the bell nearer the end of the jetties.

The plan for improving the aids to navigation at the entrance o Galveston Harbor provides for the establishment of a new third-order light on the outer end of the South Jetty, to form a range with Bolivar Point light, which latter light is to be changed from a second-order fixed white light to a five-second flash light, and that the position of the Galveston light-vessel shall be changed from time to time until the full effect of the north jetty may be determined. This plan is more fully set out under previous paragraphs relative to Bolivar Point and Galveston Harbor lights.

DAY OR UNLIGHTED BEACONS.

The beacons are in fair condition.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

851. Trinity Shoal light-vessel, No. 43, Gulf of Mexico, Louisiana.—This 12-inch steam whistle was in operation about 195 hours, and consumed about 11 tons of coal.

BUOYAGE.

The buoyage in this district is in good condition. A whistling buoy was placed off Brazos River, Texas, and 2 second-class can buoys were placed to mark wrecks near Ship Island, Mississippi; a third-class can buoy was placed to mark the gap at Horn Island, Mississippi; a first-class spar buoy was placed at Twelvemile Point, Mississippi River, to mark a shoal; a second-class can and a third-class nun were placed in Galveston Bay, Texas, and 2 third-class nun buoys were placed to mark ballast grounds off Ship Island, Mississippi. The buoyage at the entrance to Galveston Bay, Texas, was rearranged on account of a change in the position of the light-vessel. With the present arrangement the best water is marked, and the buoyage is rendered more beneficial. During the year 9 new buoys were established, and 4 discontinued. Ten third-class nun, 10 third-class can, and 6 spar, first class, were received.

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DEPOT.

Port Eads, La.—The depot is in good condition. The slight damage done by the October storm was repaired. At present all chains, except a small quantity for light-vessels, are kept on a temporary platform of refuse planks in the swamps, while all mushroom anchors and a few buoys are in the open air. The depot is so small that it is very badly crowded.

TENDERS.

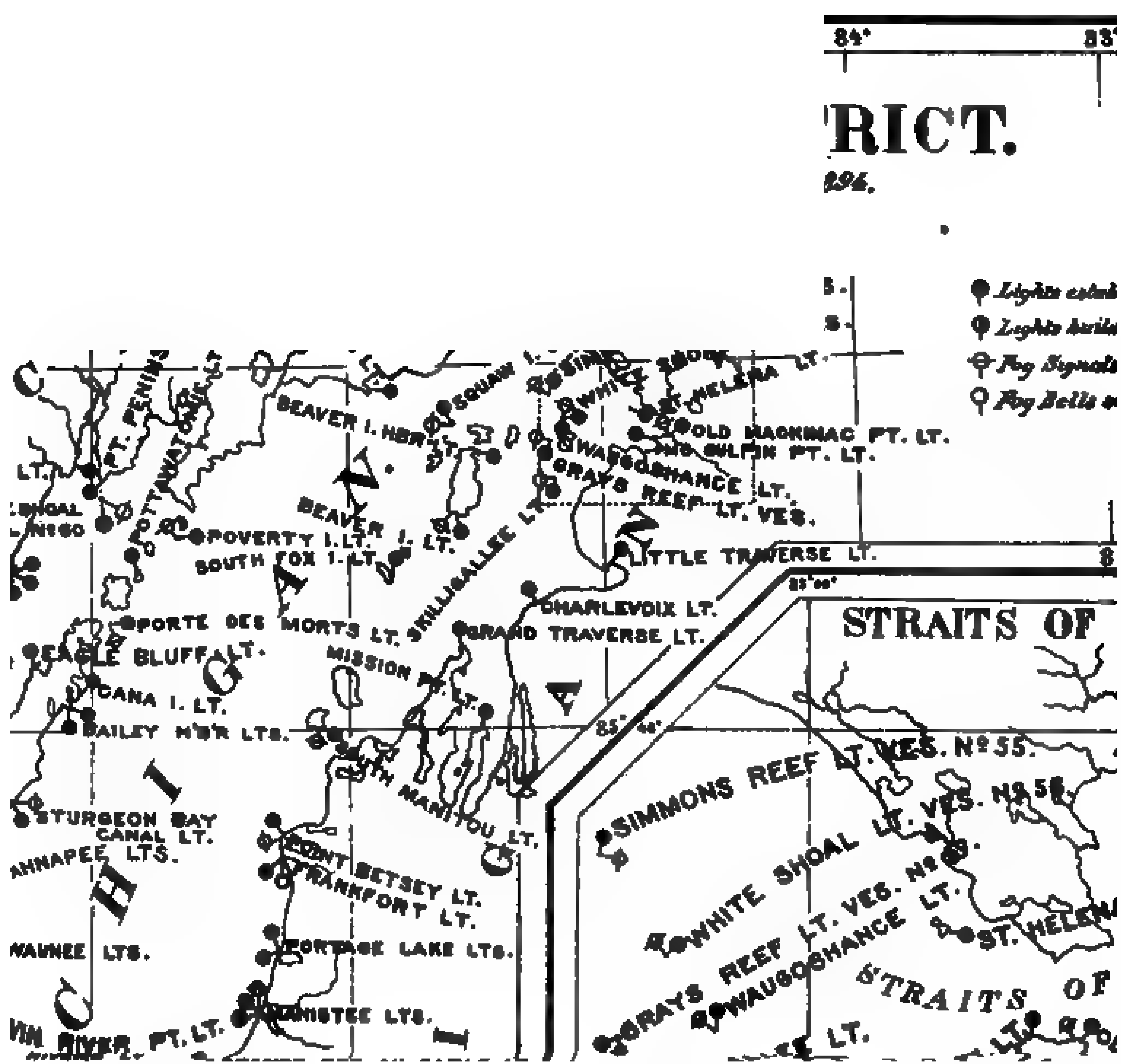
The Arbutus.—This steamer was actively employed during the year in making repairs to stations in the Seventh and Eighth light-house districts. During the year the vessel was docked and the following repairs were made: The propeller shaft was lined up, and the blades of both propellers; outboard bearings were refilled; the valve stems were repaired, as were blocks and link chocks; new brasses were made for the air pump. A new feed pump was furnished for the starboard engine. During the year the vessel ran about 14,681 miles and consumed some 848 tons of coal.

The Pansy.—This steamer was employed during the entire year, except 35 days during which she was undergoing repairs. The repairs to the machinery consisted of a new set of brass-tinned tubes fitted in the condenser, repairs to the piston and packing crosshead, a new port propeller wheel was furnished, repairs to the pipe work and the main boiler. New smokestack and breeching were furnished to the donkey boiler, The boiler is old and requires constant patching to enable the ship to continue her duty. The bulwarks were thoroughly scaled, scraped, and painted. The vessel was employed in conveying the inspector on regular quarterly visits and supplying the light-stations. During the year she placed 9 new buoys, replaced 18, recovered 10, changed 76, and cleaned and painted 110 buoys. She steamed about 9,936 miles and consumed some 571 tons of coal.

Hired Vessels.—The damage done to various light-stations in the Eighth district by the storm of October 1, 1893, made it necessary to hire two schooners to assist in the repairs. The period of their engagement and expenses, which included crew and subsistence for a working party, is as follows:

Schooner *Camille*, from October 13, 1893, to June 30, 1894, $8\frac{19}{31}$ months, at $385	$3,315.97
Schooner *Sidney*, from December 1, 1893, to February 13, 1894, $2\frac{13}{28}$ months, at $385	945.75
Total	4,261.72

10


RICT.
84°
85°
Lights estab
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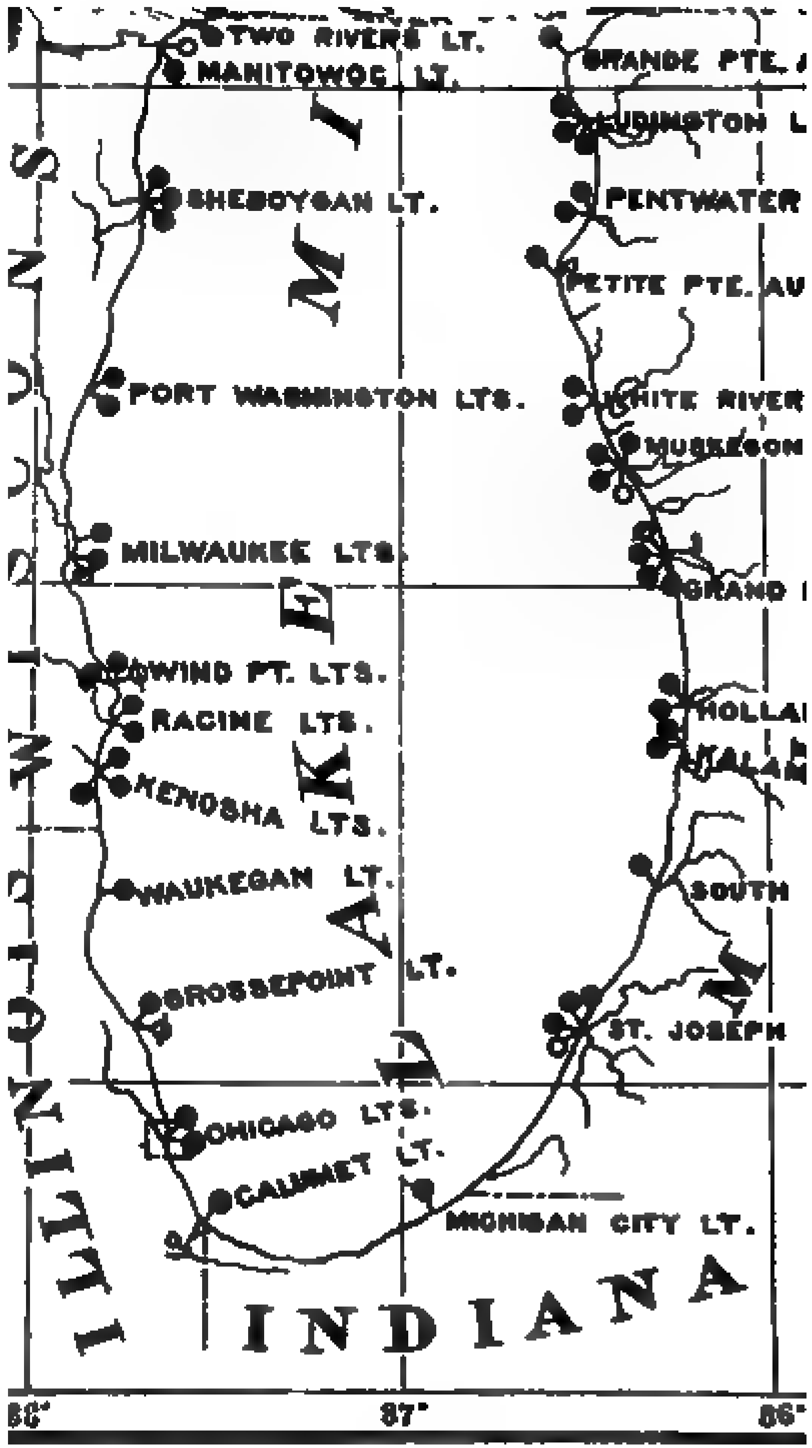
Fog Signals
Fog Bells
BEAVER I. HBR. LT.
BEAVER I. LT.
POVERTY I. LT.
SOUTH FOX I. LT.
SKILLIGALLEE LT.
OLD MACKINAC PT. LT.
WAUGOSHANCE LT.
GRAYS REEF LT. VES.
LITTLE TRAVERSE LT.
CHARLEVOIX LT.
GRAND TRAVERSE LT.
PORTE DES MORTS LT.
EAGLE BLUFF LT.
MISSION PT. LT.
CANA I. LT.
BAILEY H'B'R LTS.
SOUTH MANITOU LT.
STURGEON BAY CANAL LT.
POINT BETSEY LT.
FRANKFORT LT.
PORTAGE LAKE LTS.
MANISTEE LTS.
STRAITS OF
SIMMONS REEF LT. VES. Nº 55.
WHITE SHOAL LT. VES. Nº 56.
GRAYS REEF LT. VES. Nº
WAUGOSHANCE LT.
ST. HELENA
STRAITS OF



TWO RIVERS LT.
MANITOWOC LT.
SHEBOYGAN LT.
PORT WASHINGTON LTS.
MILWAUKEE LTS.
WIND PT. LTS.
RACINE LTS.
KENOSHA LTS.
WAUKEGAN LT.
GROSSEPOINT LT.
CHICAGO LTS.
CALUMET LT.
MICHIGAN CITY LT.
ST. JOSEPH
SOUTH
GRAND
PENTWATER
WHITE RIVER
MUSKEGON
L A K E
M I
W I S C O N S I N
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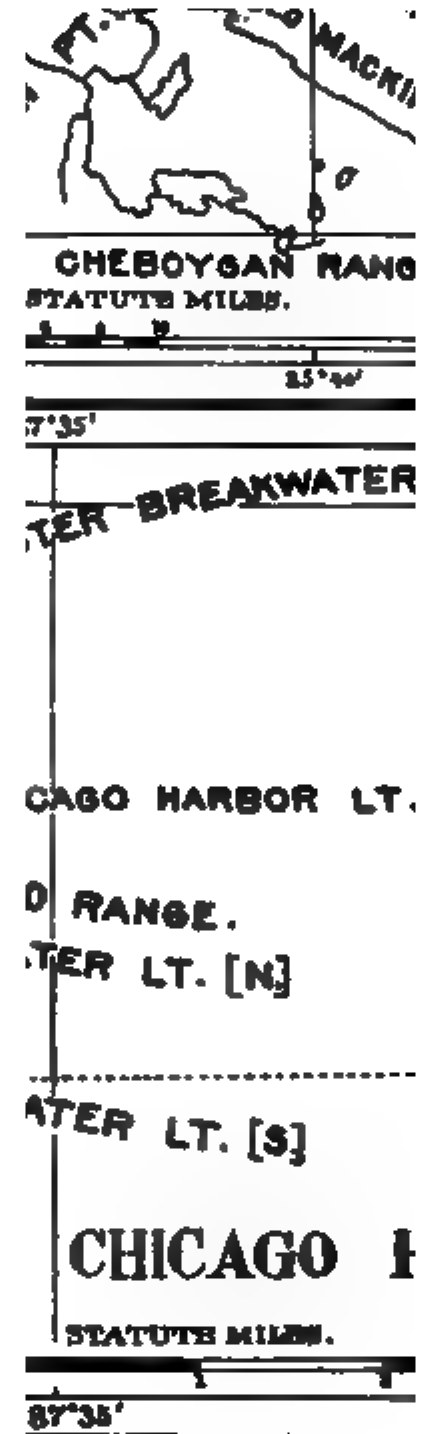
INDIANA
88°
87°
86°



CHEBOYGAN RANG
STATUTE MILES.
87°35'
BREAKWATER
CAGO HARBOR LT.
RANGE.
TER LT. [N]
ATER LT. [S]
CHICAGO
STATUTE MILES.
87°35'

NINTH DISTRICT.

The Ninth district includes all aids to navigation on Lake Michigan, Green Bay, and tributary waters, and the Straits of Mackinac, west of a line drawn across the straits from Old Mackinac Point.

Inspector.—Commander John J. Brice, U. S. Navy, to February 15, 1894; Commander William W. Mead, U. S. Navy, to May 1, 1894; Commander James H. Dayton, U. S. Navy, from May 1, 1894.

Engineer.—Maj. Milton B. Adams, Corps of Engineers, U. S. Army.

There are in this district—

Light-houses and beacon lights	97
Light-ships in position	4
Fog signals operated by steam	21
Fog signals operated by clockwork	7
Buoys in position	92
Steamer *Dahlia*, buoy tender, and for supply and inspection	1
Steamer *Amaranth*, engineer's tender, for repairs and construction	1
Steamer *Warrington*, engineer's tender, for repairs and construction	1
Steam launch *Lotus*, for construction and repair	1

LIGHT-HOUSES.

1297. Old Mackinac Point, Straits of Mackinac, Michigan.—The title papers for the additional land required for light-house purposes at this station, which were in the hands of the U. S. Attorney from July 24, 1893, were returned by him on January 24, 1894, unapproved, for the reason that the city council of Mackinac City claims the land as a public park. The landing crib was carried away by ice. The materials were purchased and the work of rebuilding the crib was in progress at the close of the year.

The following recommendation, which was made in the Board's last two annual reports, is renewed:

The fog-signal house is too near the dwelling and should be moved 50 feet. The established grade will require the raising of the signal house to conform to the grounds about the dwelling. It is desirable that the signal house should be moved to a safe and convenient distance from the dwelling, and space given for storage and fuel. It is therefore recommended that the lots on the east side of the light-house property be acquired. It is estimated that this can be done for not exceeding $1,000, and it is recommended that an appropriation of this amount be made therefor.

1298. McGulpin Point, Straits of Mackinac, Michigan.—A new barn was built. Various repairs were made.

1303. Waugoshance, Lake Michigan, Michigan.—The characteristic of the light was changed from fixed white, varied by a white flash every 90 seconds, to fixed white, varied by a white flash every 45 seconds. Various repairs were made.

1304. Skilligallee, Lake Michigan, Michigan.—An extension was made to the landing crib. The boathouse was moved 15 feet nearer to the

Ninth District.

lake shore, and was repaired. New boat ways 43 feet long were placed, and 12 new oak boat rollers were provided.

1307. *Little Traverse, Lake Michigan, Michigan.*—A summer kitchen was constructed. Some 200 running feet of new sidewalk, 3 feet wide, was laid around the station buildings. The old woodshed was moved, an addition was built, and the structure was converted into a barn.

1309. *South Fox Island, Lake Michigan, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

The Board recommends that the amount named be appropriated. Various repairs were made.

—. *North Manitou Island, Lake Michigan, Michigan.*—The following statement, made in the Board's last report, is repeated:

The establishment of a light and fog signal here, at a cost not to exceed $20,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

The Board recommends that the amount named be appropriated.

1311. *Mission Point, Lake Michigan, Michigan.*—A new woodshed was built. Various repairs were made.

1314. *Frankfort Pierhead, Lake Michigan, Michigan.*—The elevated walk, which was slightly damaged, on November 25, by a boat engaged in dredging the harbor, was repaired.

1315, 1316. *Portage Lake Pierhead range, Lake Michigan, Michigan.*—The following recommendation, which was made in the Board's last three annual reports, is renewed:

A dwelling for the keeper should be erected on the south shore, as there are but few houses in the vicinity which could be used as quarters. The estimated cost of the building proposed is $3,500, and it is recommended that an appropriation of that amount be made for this purpose.

1317. *Manistee Pierhead, Lake Michigan, Michigan.*—The pierhead light and fog signal were transferred from the south to the north pier. A conduit was built on the north pier. The lantern shown from its outer end is run in and out. The conduit consists of framed trestles, erected and secured to the cross timbers of the pier with machine bolts, carrying a continuous box or conduit of 1-inch boards, sized and rabbeted, with battens and braces, and painted. The conduit is 290 feet long and extends shoreward to the new fog-signal house on the north pier. A new elevated walk, 460 running feet long, was built on this pier, extending shoreward from the rear of the fog-signal house; the old elevated walk on the south pier was taken down and 463 feet of it was transferred to the north pier. The transfer of the fog-signal plant from the south to the north pier was begun early in May and much work was done on it. Various repairs were made.

Ninth District.

1318. Manistee, main, Lake Michigan, Michigan.—A coast light at this station was reestablished on the gable end of the keeper's dwelling June 18, 1894, and the beacon light on the south pier was discontinued on the same date. The light is a fifth-order, flashing white, varied by red flashes every 45 seconds. Various repairs were made.

1319. Grande Pointe au Sable, Lake Michigan, Michigan.—A new well was driven and various repairs were made.

1320. Ludington North Pierhead, Lake Michigan, Michigan.—A boathouse was erected, together with boat ways and crane.

1322. Ludington Pierhead, Lake Michigan, Michigan.—The following statement, made in the Board's last annual report, is repeated:

> The establishment of a steam fog signal here at a cost not to exceed $5,500, and the establishment of a dwelling for a keeper at a cost not to exceed $4,500, were authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

NOTE.—The following is an extract from the sundry civil appropriation act of August 18, 1894: "For establishing a steam fog signal at or near Pere Marquette light-station, Ludington, Lake Michigan, Michigan, $5,500." But no appropriation was made for a keeper's dwelling as suggested above. Recommendation is therefore made that an appropriation of $4,500 be made for this purpose.

1325. Petite Pointe au Sable, Lake Michigan, Michigan.—A plank walk was built from the building to the oil house. A new iron hand railing inside the tower for the stairs was built. Various repairs were made.

1326. White River Pierhead, Lake Michigan, Michigan.—Some 204 feet of the old elevated walk was taken down and rebuilt. Various minor repairs were made.

1327. White River, Lake Michigan, Michigan.—Some 287 feet of wire fencing with a top rail was built and two gates were provided. Various repairs were made.

1328. Muskegon Pierhead range, front, Lake Michigan, Michigan.—Materials for the construction of a conduit for running a lantern out to the end of the pier were delivered at the station.

1331. Grand Haven Pierhead, front, Lake Michigan, Michigan.—An elevated conduit on the south pier, for running in and out the lantern shown from its outer end, was begun in June, and at the close of the month much work had been done.

1333. Grand Haven, Lake Michigan, Michigan.—Some 208 running feet of sand fence was built for the protection of the site. Various repairs were made.

1337. Kalamazoo Pierhead, Lake Michigan, Michigan.—The beacon of the light discontinued in 1892 was taken down and the good material stored at the main light-house. A fixed red lantern light was reestablished on the outer end of the south pier on May 23, 1894, and was

Ninth District.

shown from the outer end of a conduit for running in and out the lantern. The conduit is 240 feet long. It extends shoreward to a small lamp house on the pier at the outer end of the old elevated walk. The walk, which extended the length of the conduit, was removed, and a platform was built at the shore end of the conduit from which to work the light. Various repairs were made.

1339. St. Joseph Pierhead range, Lake Michigan, Michigan.—A conduit 290 feet long was built. It extends shoreward to the pierhead light-tower. A ladder 16 feet long was secured to the lantern post at the end of the conduit.

1340. St. Joseph Pierhead, Lake Michigan, Michigan.—Some 120 feet of the elevated walk, damaged during a storm in October, was entirely rebuilt. The beacon was moved in June, 1894, 112 feet nearer the outer end of the north pier, and it was secured at each corner to the pier ties with leg irons bolted to the beacon. Some 480 running feet of new elevated walk was erected on the north pier. Stairs were placed leading from the pier to the elevated walk at the shore end, also from the elevated walk to the entrance to the beacon at the outer end. Various repairs were made.

The following statement, made in the Board's last annual report, is repeated:

> The establishment of a fog signal here, at a cost not to exceed $5,000, was authorized by the act of February 15, 1893, but no appropriation has yet been made. The Board recommends that the amount named be appropriated.

1341. St. Joseph, Lake Michigan, Michigan.—The keeper's dwelling was connected with the city water mains. The alley fence in the rear of the keeper's dwelling, 132 feet long, was rebuilt, and a double and single gate were provided. Various repairs were made.

1342. Michigan City, Lake Michigan, Indiana.—A drive well for furnishing water supply for the station was sunk. The well is 83 feet deep and furnishes a good supply of water. Various repairs were made.

The Board is of opinion that a fog signal, operated by steam or hot air, at this station would be a valuable aid to navigation. It is estimated that it could be established for a sum not to exceed $5,500, and it is recommended that an appropriation of that amount be made therefor.

—. *Chicago River, Lake Michigan, Illinois.*—The light here was discontinued on November 9, 1893, and the illuminating apparatus was taken down, packed and boxed, shipped to Detroit, and stored at the light-house depot. Measurements of the tower and sketches of the lantern, etc., were made with a view to making alterations and additions for use at Twin River Point. The work of taking down the skeleton iron tower was commenced on June 7, and at the close of the month all of the structure had been taken down to the top of the lower

Ninth District.

story and 24 tension rods of the latter. Nearly all of the small parts were invoiced and boxed, and other parts bundled for shipment. All parts were newly marked with white lead, punch, or chisel, and the old marks were removed.

1348. Chicago Harbor, Lake Michigan, Illinois.—This light was exhibited for the first time on the night of November 9, 1893, and the fog signal was put in operation. The erection of the metal work of the tower, under contract, which was commenced in March, was completed September 1, 1893. The interior woodwork and painting of the tower were done by day's labor. The tower was provided with a hot-water heater and system of radiators throughout, and plumbing work was put in under contract. Both cisterns in the tower basement were piped to both hand and engine force pumps, and the tank in the fifth story connected so that it can be filled from either cistern or from the lake. Two fog-signal houses were erected on the pier, one on either side of the tower. Each house is 11 feet by 24 feet in plan, 12 feet high to plate, constructed of heavy framing lumber covered with 2-inch planking, and the exterior sheathed with corrugated iron, both on the sides and roof. The station is provided with duplicate 10-inch steam whistles, engines of the Light-House Board design of 1883, and boilers of the Kingsford "Compact type." These boilers are a modification of the open fire box marine boilers, 5 feet square in plan, and 7 feet 9 inches high, surmounted by a steam dome 3 feet by 3 feet 3 inches long, and the following are the principal dimensions:

Grate surface, 20 square feet; heating surface, 488 square feet; steam space, 37 cubic feet; water space, 80 cubic feet; number of 2-inch tubes, 223, 3 feet long; distance of tubes between centers, 2¾ inches; water spaces of fire box legs, 3 inches.

Although proper tests for speedy raising of steam could not be made, a pressure of 5 pounds was obtained from cold water in 20 minutes, and 40 pounds in 30 minutes, on a wood fire of building refuse. During a protracted run of 14½ hours a pressure of 80 pounds was maintained with egg size Scranton coal, the damper partly closed and the furnace door ajar. Dry steam was obtained, as the boilers had been previously blown out and cleaned repeatedly.

A steel bridge was built to connect the pier upon which the light-house and fog signal stand, with the outer breakwater. Various repairs were made.

1352. Kenosha, Lake Michigan, Wisconsin.—A circular iron oil house was built.

1353. Kenosha Pierhead, front, Lake Michigan, Wisconsin.—A conduit was built on the north pier for running in and out the lantern shown from its outer end. The conduit is 104 feet long and extends shoreward to the pierhead light-tower.

1354. Kenosha Pierhead, rear, Lake Michigan, Wisconsin.—The beacon

Ninth District.

was slightly damaged by a schooner entering the harbor during a gale on the night of November 25, 1893. The beacon was repaired.

1356. Racine Pierhead, Lake Michigan, Wisconsin.—A conduit was built on the north pier for running in and out a lantern shown from its outer end. The conduit is 288 feet in length and extends shoreward to the pierhead beacon tower. The light shown from the latter was discontinued, and the light was exhibited from the end of the conduit on the night of May 28, 1894. Various repairs were made.

1357. Wind Point, Lake Michigan, Wisconsin.—A circular iron oil house was erected.

—. *South Milwaukee, Lake Michigan, Wisconsin.*—The following statement, made in the Board's last annual report, is repeated:

Recommendation was made through the proper channel to Congress in February, 1893, for the establishment of a light at this place. South Milwaukee is a village about 10 miles south of the city of Milwaukee; it is a thriving manufacturing place of some 1,200 inhabitants. There is a large business done here in building materials. It is claimed that it will double its population within a year. The Board is of the opinion that a light should be established on the north pier at the harbor, and it is estimated that it will cost as follows:

Tower (skeleton light closed at the top, 36 feet to level of focal plane)	$1,500
Fourth-order lantern	700
Fourth-order lens and lamp	700
Elevated walk, 600 feet long, at $1.50 per foot	900
Lot for dwelling	500
Keeper's dwelling	2,500
	6,800
Contingencies	700
Total	7,500

The Board therefore recommended, and that recommendation is now renewed, that an appropriation of $7,500 be made for the purpose.

1358. Milwaukee Pierhead, Lake Michigan, Wisconsin.—A circular iron oil house was erected. Various repairs were made.

1361. Port Washington, Lake Michigan, Wisconsin.—The damaged fourth-order lens was replaced by an entire new apparatus of the same order and characteristics. A brick oil house was built. A new pump was provided for the well, and a new wooden platform was constructed. A cement sidewalk leading from the dwelling to the woodshed was laid.

1361. Sheboygan Pierhead range, front, Lake Michigan, Wisconsin.—Some 160 feet of galvanized wire rope was shipped to this station for working the post light. The elevated conduit was completed on the north pier for running in and out the lantern shown from its outer end. It is 264 feet long, and extends shoreward to the pierhead light-tower. Various repairs were made.

1363. Sheboygan Pierhead range, Lake Michigan, Wisconsin.—The following statement made in the Board's last annual report is repeated:

Ninth District.

The establishment of a fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1365. *Manitowoc Pierhead, Lake Michigan, Wisconsin.*—The following statement made in the Board's last annual report is repeated:

The establishment of a fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1367. *Twin River Point, Lake Michigan, Wisconsin.*—Plans for removing the metal tower from the discontinued Chicago River light-station, increasing its height, and reerecting it at Twin River Point to replace the present brick tower, which continues to crack and crumble, were prepared. Bids were received, in response to formal advertisement, for furnishing the additional metal work required, and a contract for it was executed. The material required for the construction of the foundation for the new tower for this station was delivered. A new 10-inch whistle, complete, was shipped to the station to replace the defective one.

1368. *Kewaunee Pierhead range, front, Lake Michigan, Wisconsin.*—A conduit was erected for running in and out the tubular lantern of the pierhead light. It is on 20 trestles framed and erected in position. The conduit is a continuous box 335 feet long from the beacon to the post at the end of the pier. The post from which the light is exhibited was surmounted by the terminal end of the conduit glazed on the sides and at the end. A galvanized iron roof, provided with a galvanized iron ventilator, covers this portion. The lower ends of the trestles, carrying the conduit, project down into the pier, and are each supported by a sill piece placed crosswise with the pier, and resting on longitudinal waling pieces at the water's edge. The tubular lantern is placed upon a car or truck built for the purpose, and a continuous three-eighths-inch line is attached to one end and carried through pulleys at the outer end; thence, through fair leaders placed at convenient distances at the top of the conduit, is carried to the beacon, where it is carried over another pulley, and then led out on the bottom of the conduit to the rear end of the car. The whole device has worked satisfactorily since November 10, 1893, when it was first put in operation.

1369. *Kewaunee Pierhead, Lake Michigan, Wisconsin.*—The rebuilding of the old lamp and store house was about half completed when the fiscal year closed. The new structure is to be 8 feet wide and 10 feet long, and is to be boarded and battened and provided with a shingle roof. The establishment of a steam fog signal at the entrance to this place was recommended in the last annual report. It was estimated that the fog signal will cost not to exceed $5,500. A double keepers' dwelling should be provided for the keepers at this station. It is estimated that it will cost not to exceed, with purchase of land for site,

Ninth District.

$7,000. This dwelling is considered to be indispensable to the proper care of the light and fog signal.

NOTE.—An appropriation of $5,500 was made for the establishment of a steam fog signal by the special act approved August 4, 1894. The work will be begun at an early day.

1371. Ahnapee Pierhead, rear, Lake Michigan, Wisconsin.—A wooden oil house was built.

1372. Sturgeon Bay Canal Pierhead, Lake Michigan, Wisconsin.—Some 800 feet of hand railing was placed on both sides of the elevated walk for its entire length. The bridge was rebuilt connecting the fog-signal pier with the elevated walk. The sidewalks were entirely renewed on the east and south sides of the keeper's dwelling. The old smokestack on signal house No. 1 was replaced with a new one. Various repairs were made. The following statement made in the Board's last annual report is repeated:

The establishment of a new coast light on shore near to the keeper's dwelling, at a cost not to exceed $20,000, was authorized by the act approved February 15, 1893, but no appropriation has yet been made therefor. The Board recommends that the amount named be appropriated.

1376. Porte des Morts, Lake Michigan, Wisconsin.—A landing crib for supporting the boat ways was built at the west landing. It consists of logs and iron bolts picked up on the beach. The crib is 12 feet wide, 20 feet long, and 5 feet deep, filled with stone. New boat ways were also built, placed in position, and provided with boat rollers. Material required for substituting steam whistles for sirens was purchased and shipped to the station. The work of making this change was begun on April 26 and was ended on May 18, 1894. A water-supply crib was built, as was a foot-bridge connecting the fog-signal building with the crib. Two small cribs were also built and placed under the bridge for its support.

—. *Porte des Morts range, Lake Michigan, Wisconsin.*—The following statement made in the Board's last annual report is repeated:

The establishment of range lights and a fog signal on the southwest side of Plum Island in the Porte des Morts Passage, at a cost not to exceed $21,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1377. Pottawatomie, Lake Michigan, Wisconsin.—A boathouse was built. Boat ways 68 feet long were built. A landing crib was built of pine and cedar logs, with cedar cross-ties. The crib was built on the site of an old one which was removed, and the material was used in the construction of the new one. The crib was filled up even with the top with large limestone rock and bowlders. Various repairs were made.

—. *Little Gull Island, St. Martin Passage, entrance to Green Bay, Lake Michigan, Michigan.*—The following statement made in the Board's last annual report is repeated:

Ninth District.

The establishment of a light and fog signal here, at a cost not to exceed $20,000 was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *St. Martin Island, St. Martin Passage, between St. Martin and Little Gull islands, entrance into Green Bay, Lake Michigan, Michigan.*—The following statement made in the Board's last annual report is repeated:

The establishment of a fourth-order light and a fog signal here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Manistique, Lake Michigan, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a coast light and fog signal here, at a cost not to exceed $32,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1379. Seul Choix Pointe, Lake Michigan, Michigan.—The Board's last annual report contained the following:

Last year an appropriation of $3,500 was asked to complete the structures at this station. Since the estimate was made the conditions have somewhat changed. There has been deterioration in the unfinished work, and the eight-hour law has made a difference in the cost of labor. It is now estimated that $5,000 is needed to complete the structures. It is recommended that the $5,000 appropriated for moving St. Marys River upper range lights, Michigan, and which it is stated under that head is no longer needed for that purpose, be made available for completing these structures.

By the act approved February 15, 1893, a fog signal was authorized for this station at a cost not to exceed $5,500, but no appropriation was made. By the act approved March 3, 1893, an appropriation of $3,300 was made to complete the fog signal at this point, but as no money had been previously appropriated for this purpose the fog signal had not been begun, and the appropriation for completion was, therefore, not available. The total cost of establishing this fog signal is estimated at $5,500, and it is recommended that an appropriation of $2,200 be made to begin this work, for the completion of which $3,300 has already been appropriated.

NOTE.—The following is an extract from the sundry civil appropriation act approved on August 18, 1894:

For completing the structures at Seul Choix Pointe, Lake Michigan, Michigan, the appropriation by the act of August 5, 1892, for moving St. Marys River upper range lights, $5,000, is made available therefor.

The proper measures for completing the structures will be taken at once.

There was also appropriated in the same act $2,200 for beginning the fog signal at Seul Choix Pointe. The work will be taken in hand immediately.

1380. Squaw Island, Lake Michigan, Michigan.—The barn is to be converted into a dwelling for the assistant keeper. The required material was delivered at the light-house depot, and will be sent to the station.

Ninth District.

1383. Escanaba, on Sand Point, Green Bay, Michigan.—The following recommendation, which was made in the Board's last four annual reports, is renewed:

A steam signal here is not essential, as the navigation of Little Bay de Noquette is quite unobstructed, and with a steam whistle on Eleven-Foot Shoal a vessel should be able to reach the point with reasonable safety. A fog bell struck by machinery in the light-station at Escanaba, on Sand Point, would be a valuable addition to the service of this station. It can be set up for about $1,100. It is recommended that an appropriation of this amount be made therefor.

—. *Gladstone, Little Bay de Noquette, an extension of Green Bay, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a light on Sanders Point, or Squaw Point, to guide into Gladstone Harbor, at a cost not to exceed $10,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Peshtigo Shoal, Green Bay, Lake Michigan, Wisconsin.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a light and fog signal here, at a cost not to exceed $10,000, was authorized by the act approved February 15, 1893, but no appropriation has yet been made therefor. The Board recommends that the amount named be appropriated.

—. *Menasha, Green Bay, Wisconsin.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

It is now difficult to make the Menasha River at night on account of the cut through the rock and the earth cut, which is found to be quite intricate. To meet this difficulty it is proposed to establish here two range lights, one to be placed on the site of the old Menasha light, which was discontinued under the operations of the act of March 3, 1859, which site is still Government property; the other to be placed on the northeast end of Doty Island, adjacent to the channel. which was dredged out in 1887.

It is estimated that these range lights can be established for a sum not to exceed $500, and it is recommended that an appropriation of this amount be made therefor.

1394. Tail Point, Green Bay, Wisconsin.—The fog bell at this station is of little or no benefit in its present location, it being so far from the channel that it can be heard only in the stillest weather, and not then if the wind is from the northward or eastward. Interested navigators urge that not only should the bell be moved, but also that the light should be moved to the spot now marked by the red can buoy, which is S. by E. ¼ E. 1,650 yards distant from the present light. A crib of sufficient size can be built in say 10 feet of water, and the present light-keeper's dwelling and tower can be moved to it, and the fog bell established on it at a cost which is estimated to be not exceeding $7,500. Recommendation is made that an appropriation of this amount be made therefor.

Ninth District.

REPAIRS.

During the fiscal year repairs more or less extensive were made at each of the following-named stations:

1299. St. Helena, Mich.
1305. Beaver Island Harbor, Mich.
1306. Beaver Island, Mich.
1308. Charlevoix Pierhead, Mich.
1312. South Manitou, Mich.
1313. Point Betsey, Mich.
1315, 1316. Portage Lake Pierhead range, Mich.
1324. Pentwater Pierhead, Mich.
1330. Muskegon, Mich.
1336. Kalamazoo, Mich.
1338. South Haven Pierhead, Mich.
1343. Calumet Pierhead, Ill.
1344. Chicago Breakwater, south, Ill.
1347. Chicago Pierhead, Ill.
1350. Grossepoint, Ill.
1351. Waukegan, Ill.
1355. Racine, Wis.
1359. Milwaukee, Wis.
1360. Port Washington Pierhead, Wis.
1364. Sheboygan, Wis.
1366. Two Rivers Pierhead, Wis.
1375. Cana Island, Wis.
1378. Poverty Island, Mich.
1381. Point Peninsula, Mich.
1383. Escanaba, Mich.
1387. Eagle Bluff, Wis.
1388. Chambers Island, Wis.
1390. Green Island, Wis.
1391. Sherwood Point, Wis.
1394. Tail Point, Wis.

OIL HOUSES.

Oil houses were built during the year at the following stations, viz: Kenosha, Wind Point, Milwaukee Pierhead, Port Washington, and Ahnapee, Wis.

LIGHT-SHIPS.

1300. Simmons Reef light-vessel, No. 55, Straits of Mackinac, Lake Michigan, Michigan.—This vessel left her moorings at the close of navigation on December 6, 1893, and went to Cheboygan, Mich., for the winter. She returned at the opening of navigation and picked up her moorings again on April 11, 1894.

1301. White Shoal light-vessel, No. 56, Straits of Mackinac, Lake Michigan, Michigan.—This vessel left her moorings at the close of navigation on December 6, 1893, and went to Cheboygan, Mich., for the winter. She returned at the opening of navigation and picked up her moorings again on April 12, 1894.

1302. Grays Reef light-vessel, No. 57, Straits of Mackinac, Lake Michigan, Michigan.—This vessel left her moorings at the close of navigation on December 6, 1893, and went to Cheboygan, Mich., for the winter. She returned at the opening of navigation and picked up her moorings again on April 12, 1894.

1382. Eleven-Foot Shoal light-vessel, No. 60, about midway between Eleven-Foot Shoal and Corona Shoal, Green Bay, Lake Michigan, Michigan.—On October 6, 1893, this vessel was established in the northern end of Green Bay in about 60 feet of water, to the southward and westward of Corona and Eleven-Foot shoals, to mark the turning point for vessels bound into Little Bay de Noquette, Michigan. The vessel shows sim-

Ninth District.

ultaneously from three lens lanterns, encircling the foremast-head, a fixed white light. The focal plane of the light is 40 feet above the lake level, and the light may be seen for 13½ miles in clear weather, the observer's eye being 15 feet above the lake level. The vessel has two masts, is schooner rigged, but has no bowsprit. There is a circular black cagework day mark at the foremast-head, and the fog signal is between the masts. The hull is black, with "Eleven-Foot Shoal" in large white letters on each side and "No. 60" on each bow. The fog signal is a 6-inch steam whistle giving blasts of 5 seconds' duration, separated by intervals of 10 seconds. She left her moorings at the close of navigation on December 6, 1893, and went to Escanaba, Mich., for the winter. She picked up her moorings again at the opening of navigation on April 17, 1894.

All the above-named light-vessels were supplied with coal for the season while in winter quarters.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

1297. Old Mackinac Point, Michigan.—The 10-inch steam whistle, in duplicate, was in operation some 396 hours, and consumed 43 cords of wood.

1300. Simmons Reef light-ship, No. 55, Michigan.—This 6-inch steam whistle was in operation some 193 hours, and consumed 23 tons of coal and 2¼ cords of wood.

1301. White Shoal light-ship, No. 56, Michigan.—This 6-inch steam whistle was in operation some 218 hours, and consumed 18 tons of coal and 2 cords of wood.

1302. Grays Reef light-ship, No. 57, Michigan.—This 6-inch steam whistle was in operation some 232 hours, and consumed 16 tons of coal and 3 cords of wood.

1303. Waugoshance, Michigan.—The 10-inch steam whistle in duplicate was in operation some 174 hours, and consumed 12 tons of coal and 12 cords of wood.

1304. Skilligallee, Michigan.—The 10-inch steam whistle, in duplicate, was in operation some 199 hours. and consumed 10 tons of coal and 10¼ cords of wood.

1306. Beaver Island, Michigan.—The first-class steam sirens, in duplicate, were in operation some 212 hours, and consumed 20½ cords of wood.

1312. South Manitou, Michigan.—The 10-inch steam whistles, in duplicate, were in operation some 555 hours, and consumed 40½ cords of wood.

1313. Point Betsey, Michigan.—The 10-inch steam whistles, in duplicate, were in operation some 418½ hours, and consumed 11½ tons of coal and 19½ cords of wood.

1318. Manistee Pierhead, Michigan.—The 10-inch steam whistles, in duplicate, were in operation some 459 hours and consumed 46¼ tons of coal and 5½ cords of wood.

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1332. *Grand Haven Pierhead, Michigan.*—The first-class steam sirens, in duplicate, were in operation some 435 hours, and consumed 37½ tons of coal and 2 cords of wood.

1348. *Chicago Harbor, Illinois.*—The 10-inch steam whistles, in duplicate, established November 9, 1893, were in operation some 297½ hours, and consumed 30½ tons of coal and 3 cords of wood.

1350. *Grossepoint, Ill.*—The 10-inch steam whistles, in duplicate, were in operation some 352 hours, and consumed 24 tons of coal and 1½ cords of wood.

1357. *Wind Point, Wisconsin.*—The 10-inch steam whistles, in duplicate, were in operation some 863 hours, and consumed 49½ tons of coal and 2 cords of wood.

1358. *Milwaukee Pierhead, Wisconsin.*—The 10-inch steam whistles, in duplicate, were in operation some 701½ hours, and consumed 36 tons of coal and 2½ cords of wood.

1367. *Twin River Point, Wisconsin.*—The 10-inch steam whistles, in duplicate, were in operation some 797½ hours, and consumed 37 tons of coal and 63½ cords of wood.

1372. *Sturgeon Bay Canal Pierhead, Wisconsin.*—The 10-inch steam whistles, in duplicate, were in operation some 595½ hours, and consumed 69 tons of coal and 4 cords of wood.

1376. *Porte des Morts, Wisconsin.*—The steam siren was discontinued, and 10-inch steam whistles, in duplicate, were established May 18, 1894. They were in operation some 322 hours, and consumed 7 tons of coal and 20½ cords of wood.

1378. *Poverty Island, Michigan.*—The 10-inch steam whistles, in duplicate, were in operation some 295 hours, and consumed 3½ tons of coal and 34½ cords of wood.

1380. *Squaw Island, Michigan.*—The 10-inch steam whistles, in duplicate, were in operation some 158 hours, and consumed 9 tons of coal.

1382. *Eleven-Foot Shoal light-vessel, No. 60, Michigan.*—The 6-inch steam whistle, established October 6, 1893, was in operation some 186 hours, and consumed 10½ tons of coal and 2½ cords of wood.

BUOYAGE.

The buoyage of the district is in good condition, and all attended to by the steam tender *Dahlia*, with the exception of Bank Point buoy in Lake Muskegon, buoy at the entrance of St. Joseph Harbor, buoys in Green Bay, south of Long Tail Point, and channel buoys in Fox River. The iron buoys were taken up at the close of navigation early in December and reset at the opening of navigation in March. During the heavy gale in May of the present year many of the buoys in the south part of the lake drifted out of position, and two were entirely lost. Since then they have all been reset. The electric buoys between the World's Fair grounds and Chicago were taken up in November.

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The only other changes during the year were as follows: Spar buoy on shoal off Madison Park, city of Chicago, was established on August 23, 1893, and third-class can buoy on Bank Point, Lake Muskegon, was changed to a second-class can buoy on June 29, 1894.

DEPOTS.

St. Joseph, Mich.—The work of grading the depot grounds and the fencing was completed. A plank walk for the use of the life-saving station was laid by that service. The necessary work for piping the grounds and providing hydrants and water meter was done, and all necessary connections were made to the dwelling. Some 575 running feet of 4-inch pipe was laid across St. Joseph Harbor in a dredged channel 20 feet below water surface to connect the water pipes of the light-house depot grounds with the city water mains. The tramway and track along the bulkhead and wharf, and from thence to the store-house, with switches and curves, a total length of 540 feet, was completed. The rail laid on the wharf and bulkhead is spiked to the deck planking and the remainder to cedar ties laid 30 inches to centers. The rails throughout the entire distance are coupled together with fish plates bolted with 4-inch machine bolts. A plank walk 2 feet 6 inches wide, secured to ties, was laid between the tracks. Various minor repairs were made.

Supply and buoy depot for the Ninth and Eleventh light-house districts, at Scammons Harbor, northern part of Lake Huron, Michigan.—The following recommendation made in the Board's last two annual reports is renewed:

There are now in service in the Ninth district 15 steam fog signals, and in the Eleventh district 20, a total of 35. Provision has been made by appropriation for the construction of several more in each district, the greater number of which will be erected during the coming year; and in addition there are recommendations, applications, and pending legislation for a number, say a dozen more, for the most of which it is probable appropriation will be made in the near future. Owing to the intricacies of navigation, the prevalence of fogs, and the somewhat frequent snow squalls and storms, not less than 24 or 25 of the steam signals to be operated will be concentrated about the northern portions of Lakes Huron and Michigan, counting from Thunder Bay Island in Lake Huron, through the Straits of Mackinac, to Point Betsey in Lake Michigan, and including the stations guarding the entrances into Green Bay.

The work of supplying the existing stations with coal is already arduous, and tasks the time of the buoy tenders, which might be employed to much greater advantage in other work. With the rapid increase in the number of the signals, it seems desirable that some better provision be made for the delivery of the fuel than its transportation from Detroit and Chicago by the single tender employed in each district. The average consumption of coal at each fog-signal station is 18 tons, so that for the 35 indicated stations near the northern ends of the two lakes there will be needed some 630 tons per annum. If some 200 tons additional be allowed for the use of the two tenders in the same region, the total amount required will be, say, 830 tons.

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The buoyage of the two districts is also steadily increasing with the greater number, draft, and tonnage of the lake shipping. Not only are there more buoys needed, but larger ones, as special difficulties are from time to time discovered and the need is discovered of greater visibility and better warning to vessels. It is quite evident, therefore, that the buoy tenders will be more taxed each year to give proper attention to the placing and relief of the buoys, many of which are now looked after by contractors in each district, to maintain the necessary frequency and thoroughness of inspections, and to keep the numerous light-stations supplied with their regular stores, all within the seven or eight months of navigation during which the work must be performed.

In the localities above indicated there are numerous points which, lying in or near the track of vessels, are dangerous to navigation by reason of not being sufficiently marked by buoys.

To provide for the convenient and economical coaling of the fog-signal stations in the two districts it will be advantageous to establish a depot at a suitable place in the vicinity of the Straits of Mackinac; and Scammons Harbor, now owned by the the Light-House Establishment, suggests itself as a place in every way desirable for the purpose. The shelter is perfect, the access is easy, and the location is sufficiently central and of ample size. It will be necessary to construct a suitable wharf, coal shed, quarters for station keeper, and other adjuncts for coaling service. In addition there should be two scows for the service of the depot, the employment of which would, in general, be as follows:

To coal the steam fog signals the scows would be loaded to a draft of, say, 3 feet and be towed from the depot to the stations. In ordinary cases the scow could go alongside and the coal be handled ashore directly and without loss of time, instead of being loaded as now into a boat from a light-house tender lying off at a distance, from which several trips must be made with oars to complete the work.

A preliminary estimate of the cost of the plant recommended is as follows:

For the wharf and buoy shed	$7,500
For quarters, etc	3,000
For two scows	4,000
Contingencies	500
Total	15,000

With the multiplication of the aids to navigation in the vicinity of the Straits of Mackinac the economy of using in certain localities light-ships of moderate dimensions and small cost in lieu of permanent light-stations, it is evident that the construction of the coaling and buoy depot for the common use of both the Ninth and Eleventh districts will be of great value to the Light-House Service. It is estimated that this depot can be established for not exceeding $15,000, and it is recommended that an appropriation of this amount be made therefor.

TENDERS.

The Dahlia.—This steamer was employed during the summer and fall of 1893 in the delivering of supplies to light-stations and light-vessels, inspection of stations, and attendance on the buoyage of the district. She took up the iron buoys for the winter early in December, after which she returned to Chicago. Her crew was discharged, and, by the courtesy of the Illinois Central Railroad, she laid up at one of the company's wharves for the closed season. On the opening of navigation a crew was employed, and the iron buoys were replaced in the latter part of

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March. Since that date she was engaged in inspection and supply trips and attendance on buoyage. She steamed during the year some 9,915 miles and consumed about 687 tons of coal. Although calking and minor repairs will lengthen her life and add to the comforts of those on board, she is in condition to meet the requirements of the district for a number of years to come.

The Amaranth.—This steamer was employed during the season in delivering materials for repairs and improvements at Waukegan, Manitowoc, Twin River Point, Baileys Harbor, Porte des Morts, Eagle Bluff, Point Peninsula, Waugoshance, Squaw Island, Seul Choix Pointe, South Manitou, Milwaukee Pierhead, and Eagle Bluff light-stations, with material required in the construction of Chicago Harbor light-station, Illinois, and returning materials from Waugoshance light-station. She was also employed in placing the sinker for mooring and in towing the Eleven-Foot Shoal light-ship to its position. During the year she steamed some 2,063 miles, and in doing so used about 160 tons of coal.

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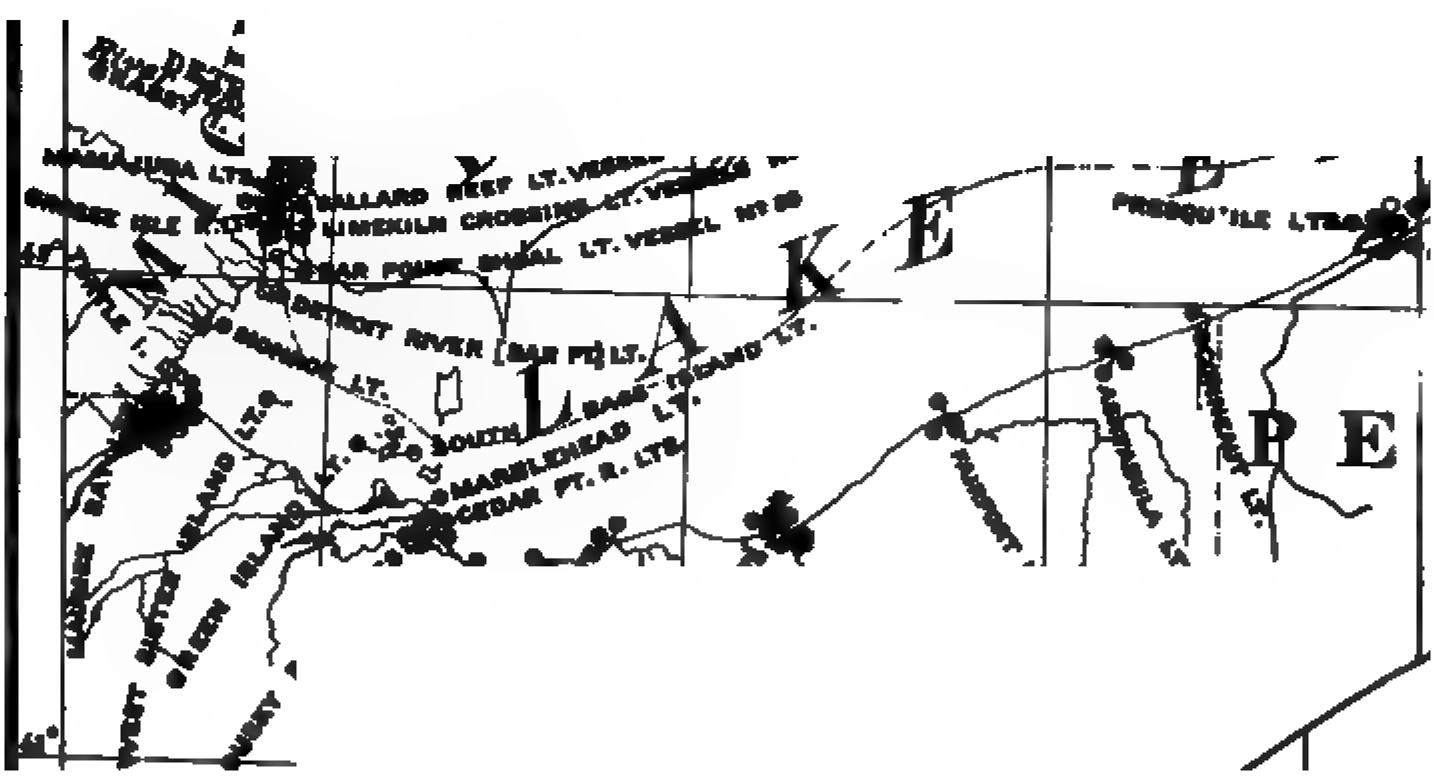
Lights building or to be
Fog Signals operated by
Fog Bells struck by m



steam or hot air
achinery
LAKE ONTARIO
OF
GALLOO ISLAND LT.
STONY POINT LT.
OSWEGO LT.
FAIR HAVEN LT.
BIG SODUS LT.
CHARLOTTE H'R LT.
BRADDOCK PT. LT.
GENESEE LT.
OAK ORCHARD
THIRTY-MILE PT. LT.
OLCOTT LT.
FORT NIAGARA LT.
NIAGARA RIVER R. LTS.
BUFFALO LTS.
HORSESHOE REEF LT.
DUNKIRK LTS.
NEW YORK
NNA.
OGDENSBURG LT.
NEW YORK
CROSS-OVER I. LT.
SUNKEN ROCK LT.
ST. LAWRENCE RIVER

TENTH DISTRICT.

The Tenth district extends from the mouth of the St. Regis River, New York, to the River Rouge, Detroit River, Michigan, and embraces all the aids to navigation on the American shores and waters of lakes Ontario and Erie, and the St. Lawrence, Niagara, and lower part of Detroit rivers.

Inspector.—Commander James G. Green, U. S. Navy.

Engineer.—Lieut. Col. Jared A. Smith, Corps of Engineers, U. S. Army.

In this district there are—

Light-houses and beacon lights	74
Light-ships in position	4
Fog signals operated by steam	6
Fog signals operated by clockwork	3
Buoys in position	144
Steamer *Haze*, buoy tender, and for supply and inspection	1

The lights in this district are classified as follows:

Third order	6
Fourth order	23
Fifth order	6
Sixth order	20
Tubular lanterns	2
Lens lanterns	13
Reflectors	8
New lights established	3
New light-vessels established	4
Steam fog signals established	4
Buoys discontinued	3
New buoys placed	8

All the light-stations and buoys of the district were inspected as frequently as practicable, and the light-stations were supplied with material in May and June.

The number preceding the name of a light-station is that by which it is designated in the List of Lights and Fog Signals of the United States on the Northern Lakes and Rivers, corrected to the opening of navigation, 1894.

LIGHT-HOUSES.

1052. Ogdensburg, St. Lawrence River, New York.—An ice house was built. Some 25 feet of plank walk was laid leading from the oil house to the door of the tower. The circular iron oil house, previously purchased, was erected upon a concrete foundation. It has an inside furring of brick laid in cement. The fourth-order Hains lamps were replaced with Funck-Heap lamps. Various minor repairs were made.

—. *Bay State Shoal, St. Lawrence River, New York.*—The following statement made in the Board's last annual report is renewed:

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The establishment of temporary floating lights here, at a cost not to exceed $800, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. *Carlton Island, St. Lawrence River, New York.*—The following statement made in the Board's last annual report, is repeated:

The establishment of this light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1058. Tibbetts Point, St. Lawrence River, New York.—The following statement made in the Board's last annual report, is repeated:

The establishment of a steam fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 6, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1060. Galloo Island, Lake Ontario, New York.—The following statement made in the Board's last annual report, is repeated:

The establishment of a steam fog signal, at a cost not to exceed $5,700, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

Minor repairs were made.

1061. Stony Point, Lake Ontario, New York.—Some 20 rods of rail fence and 16½ rods of stone wall on the division line were rebuilt. Minor repairs were made.

1062. Oswego, entrance to Oswego Harbor, Lake Ontario, New York.—On August 29, 1893, the pier on which the light-house stands was severely damaged in a heavy gale from the northeast. The stairs and entrance to the oil house and tower were torn away, and the boathouse was completely wrecked. Extensive repairs were made to the pier. The old stairway entrance was entirely closed and a new one was constructed on a sheltered site. A new boathouse was constructed at a point where it can not be reached by the sea in storms. Various minor repairs were made.

1063. Oswego Breakwater, entrance to Oswego Harbor, New York.—This station is in good condition, but needs some modification for the protection and comfort of the keepers who often have to remain several days at the beacon in storms.

1064. 1065. Fair Haven, entrance to Little Sodus Bay, New York.—Some 230 running feet of elevated walk was rebuilt, and about 200 running feet of floor was relaid with plank. Some 260 running feet of board fence, 5 feet high, on the south side of the reservation, was rebuilt. Minor repairs were made.

1069. Genesee, Charlotte Harbor, Lake Ontario, New York.—The deck of the crib beneath and around the signal house was covered with new plank, and the upper courses were rebuilt to make it sufficiently strong. The beacons and dwelling are in fair condition. The Rochester Electric Railway Company, of Rochester, N. Y., paid $25 for rental for part of the light-house reservation under the lease. The steam fog

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signal at this station, authorized by act of Congress approved March 3, 1891, was completed and ready for operation on September 30, 1893. Its location is on the old light-house crib on the west side of the west pier, mouth of the Genesee River. The building is a wooden frame structure, covered outside with corrugated and inside with smooth iron, and rests upon a low truss work of heavy timbers braced with iron rods and firmly secured to the top of the crib. To make a secure foundation for the fog signal, a part of the superstructure of the old light-house crib was removed and rebuilt with new timber. The whole crib received a new deck, and the superstructure was sheathed on the outside with 3-inch plank. Some minor repairs were made.

1071. Braddock Point, Lake Ontario, New York.—Plans and estimates for the station buildings are being prepared.

1073. Thirty-Mile Point, east of Niagara River, Lake Ontario, New York.—A new fence, 825 feet long, was built on the reservation line. Various repairs were made.

—. *Wilson Harbor, Lake Ontario, New York.*—The following statement made in the Board's last annual report is repeated:

The establishment of this light, at a cost not to exceed $2,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1075. Fort Niagara, Niagara River, Lake Ontario, New York.—The ditch extending along nearly the entire front of the reservation was filled in with earth, first laying 6-inch pipe for drainage, and a wooden bridge at the entrance to the grounds was built. A steel water tank, erected on the Fort Niagara military reservation, so that it obscured the light of this station from lake points, was removed to a new location, where it no longer hides the light to vessels. Minor repairs were made. The dwelling at this station is old, in bad condition, and unsuitable. It is estimated that a suitable dwelling can be built for not exceeding $4,000, and it is recommended that an appropriation of this amount be made therefor.

1076, 1077. Niagara River range, Niagara River, New York.—In order to mark the channel of deepest water where it has been improved below the channel which is marked by the Horseshoe Reef light-house, the front light of this range was moved to a new structure located on the berm bank of the Erie Canal about 71 feet south of the old site. The new structure is an open framework of wood with a small house at the top for exhibiting the light.

1078. Horseshoe Reef, entrance to Buffalo Harbor, New York.—During the gale of October 14 and 15, 1893, the wooden crib protection was injured. The damage was repaired, excepting that the stone has not been replaced.

1079. Buffalo Breakwater, north end, Lake Erie, New York.—The steam fog signal authorized at this station by act of Congress approved August

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5, 1892, was completed and ready for operation on September 30, 1893. The signal house is of the same general plan and dimensions as the one built at the Genesee light-station, New York. It is provided with closets, reflector lamps, etc., and a large coal room adjoins on the west side. The exterior is covered with corrugated and the interior with smooth iron. To provide the needed room, the keeper's dwelling with light-house was removed from its old position in the center of the crib to the northwesterly part. Heavy seas are sometimes thrown over the breakwater, striking the buildings on the light-house crib. Some small repairs were made necessary from this cause.

1080. Buffalo, main entrance to Buffalo Harbor, New York.—The pipe which supplied the station with water for domestic uses was torn up from the bed of the river by a vessel's anchor, thus cutting off the supply of water from that source. Estimates are being prepared for making the necessary repairs. Various repairs were made.

1083. Erie, outside of Erie Harbor, Presqu'ile Bay, Lake Erie, Pennsylvania.—The old wooden fence, 297 feet long, on the west line of the reservation was almost entirely rebuilt with wire and cedar posts. Natural gas, to be used for fuel, was introduced into the keeper's dwelling. The supply of gas is obtained from a well located about 30 feet from the dwelling on the south side of the reservation. Various repairs were made.

1084. Presqu'ile Pierhead, Erie Harbor, entrance to Presqu'ile Bay, Lake Erie, Pennsylvania.—The beacon was moved to a point about 20 feet from the outer end of the new pier extension, and about 313 running feet of new elevated walk was built to connect the walk with the beacon. The following statement made in the Board's last annual report is repeated:

The establishment of a fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1085. Erie range, No. 1, entrance to Presqu'ile Bay, Lake Erie, Pennsylvania.—The old mast supporting the light was replaced with a new one.

1086. Erie range, No. 2, entrance to Presqu'ile Bay, Lake Erie, Pennsylvania.—Some 30 feet of the west end of the north pier, supporting the beacon, was removed to the water level and rebuilt with solid bulkheads where it joins the old part of the pier. The old pier around the boathouse was rebuilt above the water level.

1087. Presqu'ile, north shore of peninsula, 3 miles from the entrance to Erie Harbor, Presqu'ile Bay, Pennsylvania.—To protect the station buildings and keeper's garden from the encroachment of sand, a tight board fence 396 feet long and 5 feet high was built on the east, north, and west sides of the dwelling. Walks about the station were repaired.

1088. Conneaut Pierhead, entrance to Conneaut Harbor, Lake Erie, Ohio.—This light was moved to the outer end of the west pier as

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recently extended. It consists of a lens lantern, protected by a wooden housing or hood with glass front, at a height of 20 feet above water level, and supported upon 2 oak timbers braced by iron rods.

1089. Conneaut, entrance to Conneaut Harbor, Lake Erie, Ohio.—This light was established in 1835, as a guide to vessels entering the harbor of Conneaut, and it was placed on the outer end of the west pier. The commerce of the place was not maintained and the piers were allowed to decay and fall to ruin. In 1885 the pier was so much decayed that the beacon was insecure and it was removed to the bluff on shore. A new and extensive enterprise is now established at Conneaut, which will probably make it a leading port in the shipment of iron and coal. The harbor is being improved at great expense, and lights to mark the entrance are now important. The old beacon upon the hill, which is of little use as a guide to the harbor or as a coast light, is now so far decayed, except as to the lantern, as to be unfit to move to the pierhead. It is therefore recommended that an appropriation of $2,500 be made for the construction of a new beacon on the end of the pier, and for a second beacon near the shore to form the rear beacon of a range; the two beacons to be connected by an elevated walk on the west pier. When the range is completed the present lights can be discontinued.

1090. Ashtabula (front), entrance to Ashtabula Harbor, Lake Erie, Ohio.—Extensive repairs to the dwelling were found necessary, and a contract was made to do the work and furnish all the materials for the sum of $1,038.50, to be completed September 30. The work was begun in June and fair progress has been made. The beacon was moved 240 feet to the end of the new pier, built in 1893, and a new elevated walk was constructed for the same distance. Some 60 running feet of elevated walk, destroyed by a storm in October, 1893, was rebuilt. The lumber and ironwork for rebuilding 640 running feet of old elevated walk was purchased and delivered at the station. Various repairs were made.

A new steam fog signal was established at this station as authorized by act of Congress approved March 3, 1891. It was completed and ready for operation September 30, 1893. It is situated on the west pier next to and adjoining the outer pierhead beacon, to which it is connected by a covered storm house over the entrance to the beacon. The timbers throughout are of white pine. The structure is covered outside with corrugated iron, and painted brown. It has a cemented floor and a large storage room for fuel. Since the fog signal was completed the pier has been extended 240 feet. The fog-signal house and machinery has, therefore, been moved to the outer end of the pier extension.

1091. Ashtabula Pierhead (rear), entrance to Ashtabula Harbor, Lake Erie, Ohio.—This beacon was fitted with apparatus for hoisting the lanterns into position for displaying the light. The lights were exhibited for the first time September 25, 1893. The tower is a triangular

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skeleton pyramid of wrought iron; it was erected in 1891, but was not lighted owing to lack of funds. On May 17, 1892, the schooner *Chippewa*, in tow of the tug *John Gordon*, collided with the beacon and caused it to fall. The parties responsible for the damage, having failed to pay the expense of repairs, the matter was placed in the hands of the U. S. attorney for the northern district of Ohio, for legal action.

1093. Fairport Pierhead (front), mouth of Grand River, Lake Erie, Ohio.—The following statement, made in the Board's last annual report, is repeated:

The establishment of a fog signal, at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named, together with $400 for a range light, be appropriated.

1094. Fairport Pierhead (rear), east pier, entrance to Fairport Harbor, mouth of Grand River, Ohio.—This beacon was completed by fitting the tower with apparatus for raising and lowering the lanterns for exhibiting the light. The light was first shown on October 15, 1893. The tower is a skeleton iron pyramid, with small room constructed in one of the tower sections for trimming the lamps. The lanterns are raised to the top of the tower. The light consists of three lens lanterns suspended in a vertical line, the middle one being red, and the two others being white lights.

—. *Cleveland, on the hill at the east side of Cleveland Harbor, Ohio.*—The following recommendation, made in the Board's last annual report, is renewed:

The illuminating apparatus remains in the tower in the same position it occupied before the light was discontinued at the close of navigation in 1892. The dwelling is, however, the only place at present provided for the keepers of the harbor lights and fog signal. The house is in the city, at the corner of Main and Water streets, on the high level, and affords no view of either of the lights. The distance from the dwelling to the nearest of four lights is about two-thirds of a mile; and to the breakwater light, with revolving apparatus and fog signal, the distance is about a mile by the route which must be followed. The distance is a matter of great inconvenience to the keepers, and sometimes of danger to the lights. The present dwelling, though an excellent house, is entirely unsuited to the use of several keepers. It is recommended that a site be constructed for the dwelling and storehouse by filling in the water adjacent to the west pier. The storehouse is much needed. A suitable dwelling can then be built in a place convenient to the lights. It is proposed, when the new dwelling is completed, to sell the old site and buildings. Inquiry regarding value of real estate in the vicinity of the present light-house site and dwelling indicates that the old site may be sold for about $24,000 or $25,000. The expense of the new site, dwelling, and storehouse is estimated to be $25,000, and it is recommended that an appropriation of this amount be made therefor.

Various minor repairs were made.

1096. Cleveland west pier, entrance to Cleveland Harbor, Lake Erie, Ohio.—The elevated walk was so badly decayed and broken as to be unsafe; it has, therefore, been removed and replaced with 1,150 feet of new walk. Extensive repairs were made to the beacon.

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1097. Cleveland Breakwater, entrance to Cleveland Harbor, Ohio.—To prevent the vibration of the crib and beacon when struck by heavy seas, 269 cords of heavy riprap stone were placed on the east and south sides of the crib. A strong protection of timberwork was built between the tower and the fog-signal house to shield the passageway from the heavy seas. The floor of the signal house was covered with Portland cement, to afford a drainage and to provide a better surface for cleaning. The station was broken into by unknown parties before the opening of navigation, 1894, and tools were stolen. The doors, locks, etc., which were injured were repaired. Various repairs were made.

1099, 1100. Black River Pierhead range lights, entrance to Black River Harbor, Lake Erie, Ohio.—The rear beacon of this range was fitted with hoisting apparatus for exhibiting the light, which was first displayed October 15, 1893. The rear beacon, which was a skeleton iron tower, fell on June 22, 1894, by being run into by the schooner *Alta* while being towed away from the west pier in front of the beacon, where she had been lying contrary to the protests of the light-keeper. A request has been made for the payment of the estimated cost to reerect the tower. A new beacon will be erected in a position less exposed to collision.

The establishment of a fog signal at a cost not to exceed $4,300, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1101. Vermillion, entrance to Vermillion Harbor, Lake Erie, Ohio.—The iron beacon was moved to within about 25 feet of the outer end of the pier and the timbers of the beacon foundation, which were decayed, were replaced. Some 56 running feet of elevated walk was built to connect the beacon in its new position with the old walk. In April, 1893, the schooner *M. S. Bacon*, in tow of the tug *J. P. Devney*, collided with the beacon in such a manner as to cause serious injury. Repairs were made and the expense, $161.62, was collected and paid into the U. S. Treasury by the U. S. attorney at Cleveland, Ohio. Various minor repairs were made.

1102. Huron, entrance to Huron Harbor, Lake Erie, Ohio.—Some 400 running feet of elevated walk on the west pier leading to the pierhead beacon were rebuilt with new material, and general repairs were made to the deck and other parts.

1103. Cedar Point, entrance to Sandusky Bay, Lake Erie, Ohio.—The elevated walk, 486 feet in length, leading from the dwelling to the front beacon, was rebuilt. A small shed for storage was erected. Various minor repairs were made.

1105, 1106, 1107. Sandusky Bay ranges, on the outer bank at the elbow of the dredged channel, Sandusky Bay, Ohio.—The main crib and the boat harbor were repaired and strengthened, and five rooms in the

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dwelling were papered. The following recommendation made in the Board's last annual report is renewed:

The new straight channel will, it is understood, be completed by midsummer, 1894, and may be ready for use in the fall of 1893. As it is wider, deeper, and more direct than the old channel, the latter will be no longer needed. The range lights marking the old channel should therefore be moved at once, so as to mark the new channel. There are now two ranges formed by three beacons. Only one range of two beacons will be needed to mark the new channel. The third beacon may be discontinued. This range is very important, as the entire commerce of Sandusky is dependent upon it. The two beacons should be built anew and a dwelling for the keeper should be built near one of the beacons. The beacons should be located on the bar, in water from 5 to 7 feet deep, and on a good foundation. It is estimated that this work can be done at a cost not exceeding $25,000, and the Board recommends that an appropriation of this amount be made therefor.

The new straight channel from Cedar Point to the east end of dock channel has now been practically completed. It is wider, deeper, and more direct than the old channel; the three beacons of the present ranges are of no value for the new channel and the old channel will hereafter be very little used. A new range of two beacons is needed at once to mark the new straight channel and when completed the old ranges of three beacons will be no longer needed. The new beacons should be located on the bar, in water from 5 to 7 feet deep. The recommendation for an appropriation of $25,000 for the purpose is therefore renewed.

NOTE.—An appropriation of $25,000 was made in the sundry civil appropriation act approved August 18, 1894, for moving and rebuilding the range lights and building a keeper's dwelling. The work will be taken in hand at an early day.

—. *South Bass Island, Lake Erie, Ohio.*—The following statement made in the Board's last annual report is repeated:

The establishment of a light, at a cost not to exceed $8,600, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

NOTE.—An appropriation of $8,600 was made in the sundry civil appropriation act approved on August 18, 1894, for this purpose. The work will be begun at an early day.

1109. Green Island, on the west end of Green Island, Lake Erie, Ohio.—To enable the light-house tender to land with supplies the wharf was extended 30 feet and made 16 feet wide, with an ell on the east side to make the wharf front 32 feet wide. The work is the usual type of crib work filled with stone.

—. *Port Clinton, Lake Erie, Ohio.*—The following statement made in the Board's last annnual report is repeated:

The reestablishment of a light, at a cost not to exceed $1,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

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1110. West Sister Island, on the southwest end of West Sister Island, Lake Erie, Ohio.—A new chimney, topped with smoke pipe and ventilator, was provided for the kitchen. The wharf was extended to water 10 feet deep to permit the light-house tender to land supplies and to use the station as a buoy depot. The new part of the wharf extends outward 66 feet and has a front of 50 feet. An opening 25 feet wide is left between the new and old parts, and the opening is spanned by a substantial bridge.

1111. Turtle Island, entrance to Maumee Bay, Lake Erie, Ohio.—New winch and rollers were provided for the boathouse, and materials were obtained for repairing the boat ways. Minor repairs were made.

1112, 1113, 1114. Maumee Bay ranges, Maumee Bay, Lake Erie, Ohio.—Two new lens lanterns and one tubular lantern, each of 360°, were ordered for increasing the light at the beacons and showing lights to mark the straight channel in the direction of the lake. Steps were taken to change the beacon lanterns to accommodate the modified lights. A circular iron house for oil storage was erected upon a concrete foundation on the crib at the northeast beacon of the ranges. A substantial boathouse resting upon heavy oak piling was built east of and adjacent to the main crib. As the main and east cribs are very badly decayed above water, material has been purchased to rebuild them. The new straight channel was completed as originally designed, 200 feet wide and 17 feet deep. The outer end is, however, still unlighted by a range and is therefore difficult to navigate at night. Plans were made to partially remedy the difficulty by removing the gas machines and substituting lens lanterns at the main and east cribs and a tubular lantern at the south crib.

The following recommendation, made in the Board's last annual report, is renewed:

The Maumee Bay range was not built with reference to the present conditions, but was to light a part of the old channel only 2 miles long. Instead of lighting this single stretch of 2 miles, this range also lights a second stretch of 3 miles in length leading seaward into the lake. As the site of the range is between these two stretches, vessels coming in or going out must pass around the side of the range by a special channel. It is therefore necessary to arrange the beacons so that the channel may be lighted in both directions. The present front beacon is a common portable lantern with small reflectors. At night the lantern is placed on a small platform on the roof of a shed close to the keeper's dwelling, which stands on a crib. The present rear beacon is a lantern on an iron column standing on a crib filled with stone. The distance between the lights is only 1,035 feet. The arrangement is inadequate for future necessities. The channel may be ultimately made 300 feet wide, but the present plans contemplate a width of only 200 feet for the longest reach. The distance between the beacons is already too small for a good range in so long and narrow a channel. The beacons should be made to serve as day marks. This is not the case with the present arrangement. It is therefore necessary to build a new beacon at each end of the range, with lenses to light the entire arc of 360°, and so arranged that both lights will mark the range both outward and inward on the line of the channel. The distance between the beacons may be increased by

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this arrangement to about 1,240 feet. The keepers must live in a dwelling on a crib at one end of the range, which is now inclosed by a double row of piles and waling pieces extending the entire distance and uniting in points beyond the lights at each end. The place is in the open bay, and a walk between the lights will be a necessity. This range is the most important in this district. When it is completed the light now maintained for the south range may be discontinued. It is estimated that the new range beacons and walk can be built for not exceeding $15,000, and it is recommended that this amount be appropriated for that purpose.

The estimated cost in the last annual report is considered too small to provide substantial beacons for so exposed a situation. An appropriation of $25,000 is recommended for constructing the beacons. At present it is not considered feasible to connect the beacons by a walk. The commerce of Toledo is now entirely dependent upon the new channel, and its proper lighting is a matter of great importance.

—. *Grassy Point range lights, Straight Channel, Maumee Bay, Ohio.*—These lights, more properly designated as Manhattan Point range, are to be so indicated in the Light-House List when they are completed. A site for the rear beacon was purchased, and that for the front beacon, which is under water, was ceded to the United States by the State of Ohio. Under the appropriation of $8,000 by act approved March 3, 1893, for moving the Maumee River range lights, arrangements were made for building the two beacons. Proposals for ironwork for the foundation of the front beacon were opened June 30, 1894, and a contract will be made with the lowest bidder. Plans and specifications for the other beacon are being prepared. The work is to be done by contract.

The following recommendation, made in the Board's last annual report, is renewed:

The new range is to light the channel from the end next to the mouth of the river, and when this is done, the Maumee Inner, Maumee Middle, and Maumee Outer ranges may be discontinued. The front beacon is to be erected in the water. While the beacon may be built and furnished with illuminating apparatus on the balance of the appropriation, about $7,000, it is not enough to build suitable structures, as the site for the rear beacon will require to be graded and protected from the river currents. The Board, therefore, recommends that an additional appropriation of $2,000 be made for this purpose.

NOTE.—An appropriation of $2,000 was made for this purpose in the sundry civil appropriation act approved August 18, 1894. The work of constructing the beacons is now in progress.

1119, 1120. Maumee Inner range, Maumee Bay, Lake Erie, Ohio.—Some 76 feet of sidewalk on the east side of the street in front of the keeper's dwelling were relaid with new material in compliance with notice from the city authorities.

1121. Monroe, entrance to River Raisin, Lake Erie, Ohio.—A new circular iron house for oil storage was erected on the pier near the dwelling. It is on a substantial foundation of masonry rising 8 feet above water and is lined with brick and has iron shelving. Various minor repairs were made.

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1123. Detroit River (Bar Point), near the mouth of Detroit River, Lake Erie, Michigan.—The circular windows (dead lights) in the iron tower did not exclude wind and water in storms. They were, therefore, removed, 15 in number, and have been replaced with new ones set in composition brass frames. One window was furnished with blinds. Two openings, each 24 by 20 inches, provided with doors, were cut in the east wall of the signal house opposite the ends of the boilers for removing the boiler tubes when necessary for repair.

1127, 1128. Grosse Isle north channel range lights, Detroit River, Michigan.—A site for the rear beacon was purchased and the site under water for the front beacon, near the shore of the Detroit River, was ceded to the United States by the State of Michigan. The boundaries of the lot for the rear beacon were marked by stones and the lot was fenced. The two beacons were completed in June, and were first lighted July 16, 1894. The lights were exhibited from lens lanterns covered by the lantern of the beacons. This range marks the channel of the river northward past Mamajuda Island. It intersects the Grosse Isle south channel range and marks the turning point to safely clear the bar at the southwest point of Fighting Island when coming from or going toward the Limekiln Crossing. The appropriation for constructing this range was but $2,500. This amount has covered the cost of the hydrographic survey to determine the proper location and of the land surveys to locate the sites.

The site was paid for and the beacons were completed, but funds have not permitted the erection of a dwelling. The beacons are situated near the north end of the island, where the houses are almost exclusively owned and occupied by summer residents, and there is no place where a keeper can live within a reasonable distance. The construction of a dwelling is, therefore, essential to the proper maintenance of the lights. A suitable dwelling may be constructed for $3,500, and an appropriation of that amount is recommended for the purpose.

1129, 1130. Grosse Isle south channel range, between Fighting Island and Limekiln Crossing, Detroit River, Michigan.—Various repairs were made to the illuminating apparatus, and a new lens lantern with modified reservoir was substituted for the one previously used. Repairs were made to the roof, walls, and chimneys of the keeper's dwelling. This range is at the water's edge, near the swampy lands extending north from Grosse Isle.

The following recommendation was made in the Board's last annual report:

> A new dwelling is needed for the keeper of this range. He is now living in a dwelling on Mamajuda, which is not only unsuitable for the purpose but is too far away. It is deemed dangerous for the keeper to live on the side of the channel opposite to the lights. A proper dwelling can be built on a foundation partially in

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the water for not exceeding $5,000, and it is recommended that this amount be appropriated for that purpose.

1131. Mamajuda, on Mamajuda Shoal, Detroit River, Michigan.—Eleven cords of stone were delivered along the east shore of the island in rip-rap form to protect the shore from washing away. Various repairs were made.

1132. Mamajuda Island range light, Detroit River, Michigan.—The beacon for this light was completed and was ready for lighting July 16, 1894. This beacon in connection with the main light forms a range to the northward past Grassy Island, and is a guide to keep vessels off the shoals between Mamajuda and Grassy islands.

—. Grassy Island south channel range, on or near Grassy Island, Detroit River, Michigan.—The following recommendation, made in the Board's last annual report, is renewed:

A light is needed in connection with Grassy Island light, to form a range south from Grassy Island to intersect the new Grosse Isle range, at a point in the channel opposite to Mamajuda light-house. A proper beacon light can be established on the little island where the Grassy Island fisheries are situated for not exceeding $700, and it is recommended that an appropriation of this amount be made therefor.

1133. Grassy Island, on Grassy Island Shoal, Detroit River, Michigan.—A new plank deck was laid over the old piling at the south side of this station to afford a better landing for boats. The old wooden platform around the dwelling was removed and the space was filled with earth taken from the island near the fishery. A heavy riprap of stone was laid entirely around this island to protect the interior, which was fast washing away by reason of the decay of the wooden sheet piling which encircles the station. The quantity of stone in the riprap is about 2,380 tons. A circular iron house for storage of oil was set up at the station upon a temporary foundation; a permanent foundation could not be secured until the site was protected from the wash of the river. The house will soon be placed on a permanent foundation and will be lined with brick, which are at the site.

—. Grassy Island north channel range and keeper's dwelling, on Grassy Island, Detroit River, Michigan.—The following recommendation, made in the Board's last annual report, is renewed:

When a vessel leaves Detroit for Lake Erie it is carried by the direction of the channel and the current of the river toward the head of Fighting Island, which is low and has flats covered with water, extending 800 feet or more from the shore line toward the channel on the west side of the island near its north end. It is proposed to place range lights to mark the channel, so that vessels may take a more direct and certain course and avoid the danger of running upon the flats. In going up the river the same range will indicate the point at which the range at Grassy Island may be dropped with certainty of clearing the flats off Fighting Island. It is estimated that this range can be established for not exceeding $5,500, and the Board recommends that an appropriation of this amount be made therefor.

A keeper's dwelling is indispensable to the proper care of this station. It is estimated that it can be erected at a cost not to exceed

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$4,500; and it is recommended that an appropriation of this amount be made therefor.

1134, 1135. Grassy Island (Ecorse) range lights, Detroit River, Michigan.—The title to the site selected for the beacons of these lights was conveyed by the State of Michigan to the United States and the conveyance papers were approved by the U. S. Attorney-General. The pile foundations for the two beacons were constructed by hired labor and open-market purchases.

Congress, by act of August 5, 1892, appropriated $1,500 for the establishment of range lights above Grassy Island, Detroit River, Michigan. The range indicated is, however, neither at nor very near Grassy Island, but is located in the water on the flats on the west side of Detroit River, in the township of Ecorse, about 1⅝ miles above Grassy Island. As other ranges are proposed for Grassy Island, this range is designated as the Ecorse range. The range line passes 350 feet outside and west of the contour of 18 feet depth in the channel near the head of Fighting Island, and intersects the Mamajuda range, as previously established, at a point immediately opposite Grassy Island light-house. To avoid expensive sites on the land, submarine sites for the beacons of this range were selected upon the river flats in front of Ecorse, Mich. Title to the sites and cession of jurisdiction were conveyed to the United States by the State of Michigan. The pile foundations and platforms for the beacons were constructed and the boundaries of the site were marked by piles driven in the bottom.

An appropriation of $1,500 was made in the sundry civil appropriation act approved August 18, 1894, "for completing the range lights above Grassy Island, Detroit River, Michigan." The work will be completed at an early day.

REPAIRS.

At each of the following-named stations repairs, more or less extensive, were made during the year:

1053. Cross Over Island, N. Y.
1055. Sunken Rock, N. Y.
1056. Rock Island, N. Y.
1066. Big Sodus, N. Y.
1081. Dunkirk, N. Y.
1092. Fairport, Ohio.
1093. Fairport Pierhead, front, Ohio.
1098. Cleveland East Breakwater, Ohio.
1108. Marblehead, Ohio.
1115, 1116. Maumee outer range, Ohio.

OIL HOUSES.

The metal work for four houses was completed and set up during the past year.

LIGHT-SHIPS.

1122. Bar Point light-vessel, No. 59, Lake Erie, Michigan.—This vessel was first placed on her station on September 20, 1893. She was removed on December 6, 1893, to Detroit, Mich., where she wintered. She was replaced on her station on March 27, 1894. She is in good condition.

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1124. Limekiln Crossing light-vessel (south), No. 64, Detroit River, Michigan.—This vessel was first placed on her station on September 15, 1893. On December 6 she was removed to Detroit, Mich., where she wintered. She was replaced on her station on March 27, 1894. Her condition is good.

1125. Limekiln Crossing light-vessel (north), No. 65, Detroit River, Michigan.—This vessel was first placed on her station on September 15, 1893. On December 6 she was removed to Detroit, Mich., where she wintered, and was replaced on her station on March 27, 1894. She is in good condition.

1126. Ballard Reef light-vessel, No. 63, Detroit River, Michigan.—This vessel was first placed on her station on July 1, 1893. On December 6 she was removed to Detroit, Mich., where she wintered, and was replaced on her station on March 27, 1894. She is in good condition.

FOG SIGNALS OPERATED BY STEAM OR HOT AIR.

1069. Genesee, Lake Ontario, New York.—This 6-inch steam whistle was in operation some 116 hours, and consumed about 5 tons of coal.

1079. Buffalo Breakwater (north end), Lake Erie, New York.—This 10-inch steam whistle was in operation some 352 hours, and consumed nearly 27 tons of coal.

1090. Ashtabula, Lake Erie, Ohio.—This 6 inch steam whistle was in operation about 33 hours, and consumed a little more than 2 tons of coal.

1097. Cleveland Breakwater (east end), Lake Erie, Ohio.—This 10-inch steam whistle was in operation about 536 hours, and consumed some 36 tons of coal.

1122. Bar Point light-vesssel, No. 59, Lake Erie, Michigan.—This 6-inch steam whistle was in operation some 81 hours, and consumed about 8 tons of coal.

1123. Detroit River (Bar Point), Lake Erie, Michigan.—This 10-inch steam whistle was in operation about 110 hours, and consumed some 10 tons of coal.

The three fog bells of the district are in good condition, and the machinery operating them is working well.

BUOYAGE.

The buoyage of the district is in good condition. The steam tender *Haze* cared for the buoys in Lake Erie and Detroit River and placed those in Niagara River. Eight new buoys were placed, 1 near the entrance to Buffalo harbor, 3 in the upper part of Niagara River, and 4 in the St. Lawrence River. Three buoys were discontinued, 1 in Detroit River and 2 in the St. Lawrence River.

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DEPOTS.

The buoy houses of this district are conveniently distributed, and afford ample shelter for the spare buoys and their appendages, most of which are in good condition.

Rock Island, New York.—No repairs were made. The depot is in fair condition.

Buffalo, N.Y.—The wharf above water level was removed, and superstructure, having an area of about 178 by 12 feet, was rebuilt. The fence was repaired and the grounds were graded. The slip occupied by the light-house tender *Haze* was dredged to a depth of 14 feet by dredging 1,000 cubic yards of material. The cluster of piles, southeast corner of the slip, was repaired with new piles of oak.

New buoy depot at Erie, Pa.—The depot at Buffalo is in many respects unsuitable for the purpose; it is difficult of access, especially when the creek is partially frozen, and it is in many respects inconvenient. A new depot at a different place has therefore become necessary to the proper service of the district. The harbor of Erie, Pa., affords many points of advantage not obtained at Buffalo, and transfer of the light-house depot to that place is therefore recommended. The estimated cost of a new depot at Erie is as follows:

For the site	$7,000
For fitting it up for use	3,000
For wharf and buildings	25,000
Total	35,000

Recommendation is made that an appropriation of $35,000 be made for removing the light-house depot from Buffalo and establishing it at Erie.

Erie, Pa.—The depot at this place consists simply of a small buoy shed with a platform to bridge the space between the shed and the channel pier.

Sandusky, Ohio.—This depot is simply a buoy shed on the light-house reservation at Cedar Point. The wharf is a mere walk-way to a point where small boats can land. The place is not convenient and is not much used.

Maumee Bay, Ohio.—The depot at this place is merely a platform on the wharf, adjacent to the crib on which stands the keeper's dwelling, and a shed on the crib. The new wharves at Green Island and West Sister Island will make these places convenient for the storage of buoys and anchors.

TENDER.

The Haze.—This steamer is in good condition. Minor repairs were made during the year, a general repair of the boiler was had, and the sheathing at the water line was entirely replaced. She was employed

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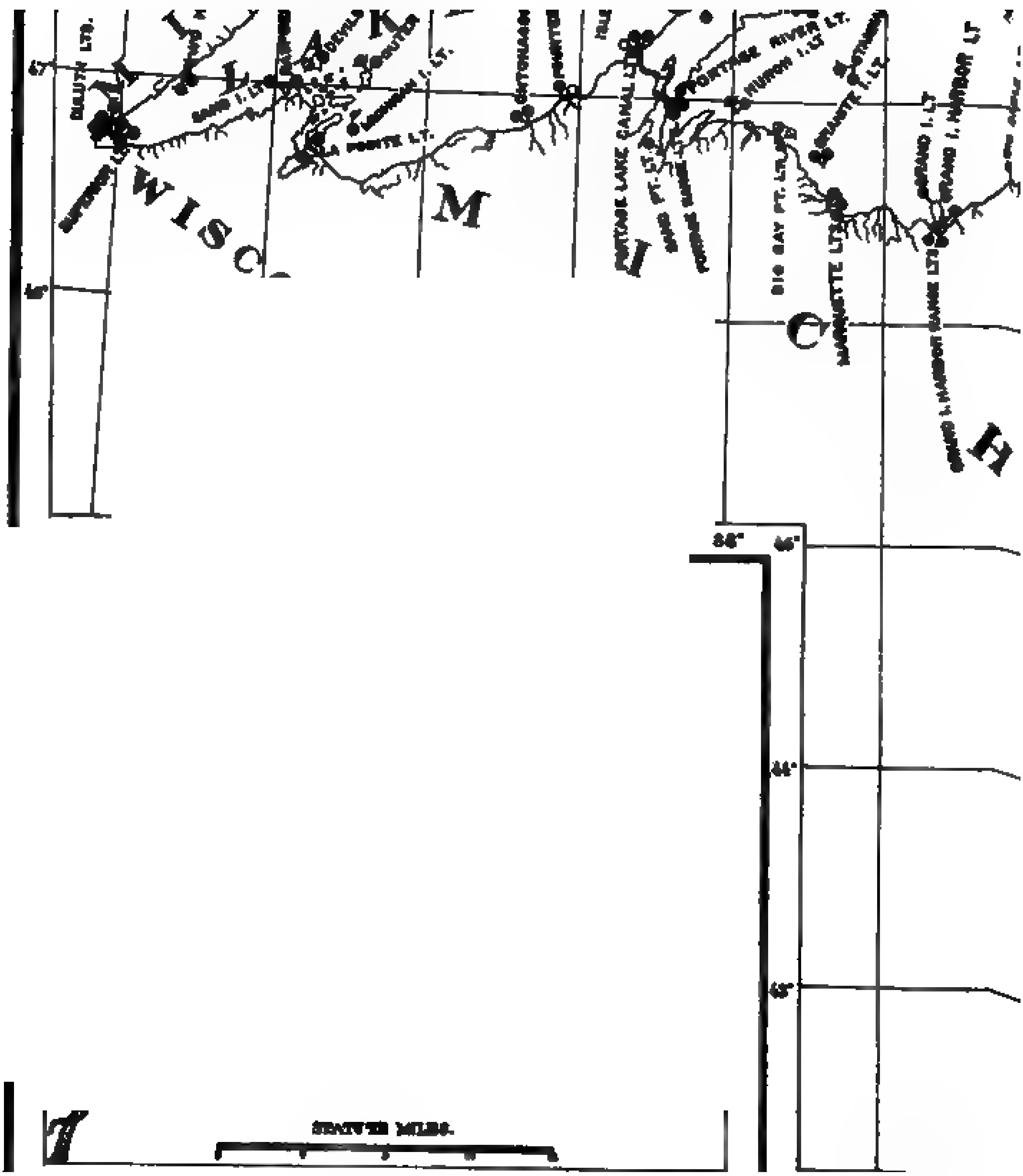
during the season of navigation in caring for the buoyage of Lake Erie and Detroit River, in painting and whitewashing the depot buildings, fences, and buoy sheds, in the delivery of four oil houses and the building materials required for them, in making inspections as frequently as practicable, and in supplying the light-stations. She was laid up at Detroit on December 15, 1893, and her crew, except the officers, the cook, steward, and one deck hand, was discharged. She left Detroit on March 27, 1894, on the buoy trip, and after completing that work, began on May 7 the supply of the light-stations, and on June 15 had finished that duty. During the year she ran some 8,860 miles, and in so doing used about 304 tons of coal.


DULUTH LTS.
LA POINTE LT.
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PORTAGE RIVER LT.
HURON I. LT.
BIG BAY PT. LT.
MARQUETTE LTS.
GRAND I. LT.
GRAND I. HARBOR LT.
GRAND I. HARBOR RANGE LTS.
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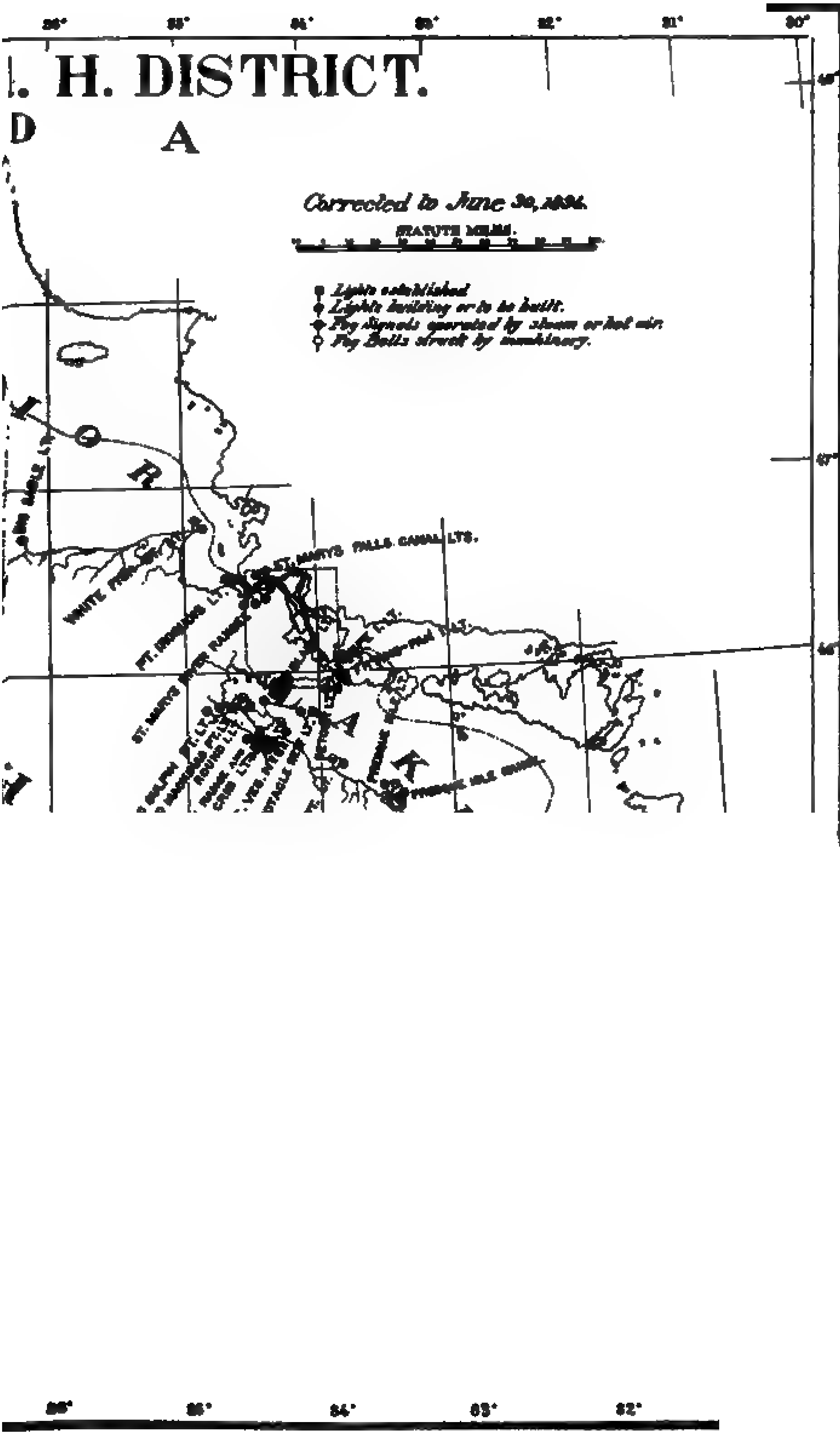
STATUTE MILES.


. H. DISTRICT.
D A
Corrected to June 30, 1894.
STATUTE MILES.
Lights established
Lights building or to be built.
Fog Signals operated by steam or hot air.
Fog Bells struck by machinery.
ST. MARYS FALLS CANAL LTS.
WHITE FISH PT. LT.
PT. IROQUOIS LT.
ST. MARYS RIVER RANGE LTS.
O R
A K

ELEVENTH DISTRICT.

This district extends from the River Rouge, Detroit River, to the head of Lake Superior, and covers the American shores and waters, above the River Rouge, of the Detroit and St. Clair rivers, lakes St. Clair, Huron, and Superior, St. Marys River, and the portion of the Straits of Mackinac eastward of a line from Old Mackinac Point.

Inspector.—Commander William W. Mead, U. S. Navy.

Engineer.—Maj. Milton B. Adams, Corps of Engineers, U. S. Army.

There are in the district—

Light-houses and beacon lights, including 19 post lights	159
Light-ships in position	3
Day or unlighted beacons	1
Fog signals operated by steam	23
Fog signals operated by clockwork	4
Bell buoys in position	2
Other buoys in position	153
Steamer *Marigold*, buoy tender, and for supply and inspection	1
Steam barge *Warrington*, buoy tender, and for supply and inspection	1
Steamer *Amaranth*, for construction and repair	1
Steam launch *Lotus*, for construction and repair	1

LIGHT-HOUSES.

1139. Windmill Point, Detroit River, Michigan.—An iron hand railing for the inside tower stairs was placed, and a storm shelter was constructed at the rear entrance to the dwelling. The sides and front of the entrance are made in sections and screwed together so that they can be taken down in the spring, leaving roof and corner posts to serve as a porch during the summer months. A new force pump was purchased and placed in position to replace the old one, which was worn out. Various minor repairs were made.

1140. Grossepoint beacon, head of Detroit River, Michigan.—The channel lies about 1,200 feet to the westward of the line now marked by the St. Clair ranges. When completed, the channel should be lighted at each end by lights placed on cribs. When this is done, the light-vessel now in use at this point could be discontinued. It is estimated that these cribs, with suitable light-house structures thereon, would cost $10,000. There is an available balance of $1,740.89 from the appropriation for St. Clair ranges made by the act approved March 2, 1889. It is therefore recommended that an appropriation of $8,260 be made for this purpose.

1144. St. Clair Flats Canal, lower, Lake St. Clair, Michigan.—A new prism of the lens was placed in position. The low places surrounding the station buildings were filled in, graded, and seeded. The filling

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consists of 39 cords of cedar bark, 286 cubic yards of sand, and 20 cubic yards of black earth.

1145. St. Clair Flats Canal, upper, Lake St. Clair, Michigan.—The low places surrounding the station buildings were filled in, graded, and seeded. The filling consists of 2 cords of cedar bark, 57 cubic yards of sand, and 14 cubic yards of black earth.

1158, 1159. Fort Gratiot range, St. Clair River, Michigan.—The electric lights formerly used at this range were discontinued and lens lanterns were substituted. A lamp house was built at the front range and guide ropes for raising and lowering the lantern were provided. A target 8 feet long and 12 feet wide, painted white, for use as a day mark, surmounts the tower.

1168. Port Austin Reef, Lake Huron, Michigan.—The material required for substituting 10-inch steam whistles for the sirens was purchased and delivered. The work was completed on June 30, the signals were tested, and the change was effected. Various repairs were made.

1176. Thunder Bay Island, Lake Huron, Michigan.—The plant of fog signal No. 1 was removed, and a new plant, consisting of the new boiler and a set of machinery, which was thoroughly overhauled and repaired at the light-house depot during the winter, was placed on a new cement foundation, built for the boiler and tested with 80 pounds steam pressure. The machinery of signal No. 2 was also overhauled, repaired, and tested.

1180. Spectacle Reef, Lake Huron, Michigan.—The plant of fog signal No. 1, which was in poor condition, was removed, and the entire apparatus was replaced with a new plant. The new apparatus was tested under steam pressure. The damage done by ice to the foundation crib at this station is about to be repaired.

1181. Detour, Lake Huron, Michigan.—A brick oil house was built. It has an iron roof, and stone doorsill and cap, and a capacity for storing 360 gallons of oil. A fire-plug ejector and new water-supply pipes were placed, and a new pipe box was constructed from the signal house to the end of the water-supply crib. Various repairs were made.

—. *Forty-Mile Point, Lake Huron, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

> The establishment of a light and a fog-signal station here, at a cost not to exceed $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

NOTE.—An appropriation of $25,000 was made for this purpose by the sundry civil appropriation act approved on August 18, 1894. The work will be immediately taken in hand.

1186. Cheboygan River range, front, Straits of Mackinac, Michigan.—A new sidewalk was laid on the street front of the keeper's dwelling, raised to the grade established by the city, and a portable driveway was constructed across the ditch. Some 143 running feet of plank walk

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were laid. Various minor repairs were made. The following recommendation, made in the Board's last four annual reports, is renewed:

The sanitary condition of this station is bad. The light-house lot is narrow and its entire front is occupied by the light-house buildings. The cellar is often innundated, and there is no drainage nor means of any except to the river over private land. It is now proposed to extend the light-house lot back to the river by purchase at an estimated expense of $1,750. Recommendation is therefore made that an appropriation of this amount be made for this purpose.

1187. Cheboygan River range, rear, Straits of Mackinac, Michigan.—The old fence was removed from three sides of the inclosure at this station and replaced with a new tight board fence 6 feet high.

—. North Passage, Mission Point, Mackinac Island, Lake Huron, Michigan.—The following statement made in the Board's last annual report is repeated:

The establishment of a light and fog-signal station on Round Island, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

NOTE.—An appropriation of $15,000 was made in the sundry civil appropriation act approved August 18, 1894, for the establishment of a light and steam fog signal at Round Island, Lake Huron, Michigan, as above recommended. The work will be taken in hand at an early day.

1188. Frying-Pan Island, Detour Passage, Michigan.—The color of the tower was changed from brown to white to render it more efficient as a day range with Pipe Island light-house. A landing crib and a pier were built to the southward of the landing crib for a protection. The crib and pier were ballasted with stone and decked over. A sidewalk was laid from the new landing crib to the dwelling, thence to intersect the walk leading to the tower.

1189. Pipe Island, Detour Passage, Michigan.—The color of the tower was changed from red to white, to render it more efficient as a day range with Frying-Pan Island light-house.

1190–1229. St. Marys River lights, from Pipe Island to Sault Ste. Marie, Mich.—Steps were taken to obtain the requisite title papers to Harwood Point range, East Neebish range, Indian Point range, and Partridge Point and Topsail Island ranges. The structure at Lower Lake George, from which the light was exhibited, was destroyed by ice. A temporary platform was placed on the end of the crib, and a post was erected from which to exhibit the light. The focal plane is 18 feet above the lake level. Sault range, rear light, was raised 15 feet, so as to show over a building that had been erected during the past winter, directly in front of it.

The following is an extract from the sundry civil appropriation act, approved on August 18, 1894:

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For lighting Hay Lake Channel, St. Marys River, forty-three thousand five hundred and fifty dollars; and the Light-House Board is hereby authorized to lease the necessary land for the sites of needed lights herein provided for, and for the sites of the lights in Saint Marys River, Michigan, provided for by the act of March third, eighteen hundred and ninety-one, pending the acquisition of the titles in accordance with sections three hundred and thirty-five and forty-six hundred and sixty-one, United States Revised Statutes, or where such lights are for temporary use or are used to point out changeable channels.

The work will at once be taken in hand.

1230. St. Marys Falls Canal, north pier, St. Marys River, Michigan.—The light was changed at the opening of navigation from a fixed red light of the sixth order, to a fixed white light of the fifth order, varied by a red flash every minute.

1234, 1235. St. Marys River upper range lights, Michigan.—There was an appropriation made by the sundry civil appropriation act on August 5, 1892, of $5,000 for moving the St. Marys River upper range lights. When this appropriation was recommended by the Board the need of moving the range was evident. Matters, however, have since been changed. The dredged channel now marked by the upper range is to be completed early in the spring of 1894. This channel will be 300 feet wide with a depth of 21 feet, thus affording the most direct route into Lake Superior, and a route which will be used by most of the vessels navigating these waters. There is a good 18-foot channel to the westward of the shoal now marked by the red can buoy known as the Waiska Bay buoy and a black spar buoy, but with the completion of the 21-foot channel, which is already lighted by the upper range lights, the necessity for additional lights in that locality, or for any change in the present lights, is avoided.

It is therefore recommended that the $5,000 appropriated by the act approved August 5, 1892, for moving the St. Marys River upper range lights be made available for completing the structures at Seul Choix Pointe light-station, Michigan.

NOTE.—The following is an extract from the sundry civil appropriation act approved August 18, 1894:

For completing the structures at Seul Choix Pointe, Lake Michigan, Michigan, the appropriation by the act of August fifth, eighteen hundred and ninety-two, for moving Saint Marys River upper range lights, five thousand dollars is made available therefor.

The work at Seul Choix Pointe will be taken in hand at an early day.

1237. Whitefish Point, Lake Superior, Michigan.—The old horizontal boiler was removed and a vertical boiler was placed alongside the vertical boiler already at the station. The two boilers were piped in combination, so that either boiler can be used separately or together on the same whistle, one engine operating both. A new well was sunk for water supply for the signals. A depth of 5 feet of water was obtained. Second-order burners were substituted for the third-order burners to

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increase the intensity of the light. The change was made on May 15, 1894.

—. *Grand Marais, harbor of refuge, Lake Superior, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a light and bell here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1238. Big Sable, Lake Superior, Michigan.—The following statement, made in the Board's last annual report, is repeated:

The establishment of a steam fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1243. Marquette, Lake Superior, Michigan.—Water from the city mains was introduced into the keeper's dwelling.

—. *Big Bay Point, between Granite and Huron islands, Michigan.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of a light and fog signal here, at a cost not to exceed $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

NOTE.—An appropriation of $25,000 was made in the sundry civil appropriation act approved August 18, 1894, for doing this work. The matter will be taken in hand at at early day.

1248. Sand Point, Lake Superior, Michigan.—Some 86 running feet of sidewalk were laid connecting the dwelling with the outhouse and boathouse. Various repairs were made.

—. *Mendota, Bête Grise Bay, entrance to Lac la Belle, Lake Superior, Michigan.*—The following statement was made in the Board's last annual report:

The reestablishment of a light here, at a cost not to exceed $7,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

The brick house of the discontinued station has been ruined by inroads of the storms of the past winter to such an extent that it can not be utilized in the reestablishment of a station here, except as material. It is estimated that it will cost not to exceed $2,500 to replace this dwelling. Hence the Board recommends that an appropriation of $10,000, instead of $7,500, be made for the reestablishment of this light.

1257. Eagle Harbor, Lake Superior, Michigan.—The characteristic of this light was changed at the opening of navigation from flashing white, varied by a white flash every 2 minutes, to flashing white varied by a white flash every minute. Various repairs were made. The following statement, made in the Board's last annual report, is repeated:

The establishment of a fog signal here, at a cost not to exceed $5,500, was author-

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ized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1258, 1259. Eagle Harbor range, Lake Superior, Michigan.—The old tin tubular lanterns at this station were replaced by lens lanterns. Various repairs were made.

1260. Eagle River, Lake Superior, Michigan.—The following statement, made in the Board's last annual report, is repeated:

The moving of this light to Sand Hills, at a cost not to exceed $20,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1261. Portage Lake Ship Canal Pierhead, Lake Superior, Michigan.—The following statement, made in the Board's last annual report, is repeated.

The establishment of a fog signal here, at a cost not to exceed $5,500, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

—. Portage Lake and River, lighting and buoying, Lake Superior, Michigan.—A joint report recommending the lighting and buoying of this lake and river was transmitted to the Board on November 10, 1893. The following is a recapitulation of the lights therein recommended:

(1) One tubular lantern (white) light on south end of east pier of ship canal.

(2) One lens lantern (8-day white) light on crib near mouth of Pilgrim River.

(3) Range, two tubular lanterns (white) at head of Portage River.

(4) Range, two tubular lanterns (white) on Princess Point.

(5) Three pile clusters, with red lanterns, to mark channel around Princess Point.

(6) Possibly an additional white light to form range with pile cluster light.

(7) Range, two tubular lanterns (white) to mark channel through cuts Nos. 2, 3, and 4.

(8) Range, two tubular lanterns (white) to lead through channel past Halles Landing.

The above lights, if established, will, it is believed, render the navigation of Portage Lake and River feasible and safe at night. For the construction of the above, the fitting and supplying of the necessary buoys, 60 in number, maintenance of the system, etc., for one season, the purchase of sites and the construction of two suitable dwellings, an appropriation of $10,500 is recommended.

1263. Fourteen-Mile Point, Lake Superior, Michigan.—Some 50 acres of land for a site at this point were purchased on the issuance of letters patent from the land office of the State of Michigan, and the patent was duly recorded. The framing for the temporary and outbuildings was done during the fall. About 6 acres of the site were cleared of brush and trees. The material needed was purchased by

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contract and collected at the light-house depot, ready for delivery at the site by the light-house tender. An order was placed for two Fitzgibbons fog-signal boilers and fixtures. On May 10 the tender *Amaranth* left Detroit with the engineer of the district, a superintendent of construction, the working party, and the necessary material for the commencement of the work. Active operations were started on the 14th, and from that date to the close of the month the following work was accomplished: The site was ditched, men's quarters were erected, a landing crib 8 feet wide and 92 feet long was placed, the excavating for the cellar and the foundation walls of the tower and dwelling and the fog signal was completed, and the drain from the cellar to the lake was laid. The footings and walls of the fog-signal house were up to grade line, about 11,000 brick being laid. The grading of the site for the boathouse was completed. About 10 acres of the site had been cleared of trees and brush at the time of commencing building operations by a workman who had been employed at this work during the past winter and 100 ties for a tramway had been prepared. During June the fog-signal building was completed, the tower and dwelling were begun and gotten well under way, and the boathouse was built. The brick oil house was completed. A tramway, leading from the landing dock to the front of the tower, was laid, and a windmill was built for supplying water, and pipes were laid to the mortar beds.

1265. Ontonagon Pierhead, Lake Superior, Michigan.—This light was moved 378 feet nearer the outer end of the pier on September 30, 1893, and new bed sills were provided; the elevated walk was extended, and a short flight of stairs were built leading from the walk to the tower.

1266. Outer Island, Apostle Group, Lake Superior, Wisconsin.—Two cribs, each 14 by 48 feet, for the boat harbor were placed, new boatways were placed in position, and a new floor was laid in the boathouse. New foundations of brick were built under both fog-signal buildings, and extended under the house containing the hoisting engine, and new sills and water table were placed. The tramway was repaired and 85 feet of new track was laid between the two signal houses. A new hoisting engine was set in position and all necessary steam connections were made. A new water tank was set in position, on a foundation, and connections between the tank and boiler were made. Various repairs were made.

1267. Michigan Island, Apostle Group, Lake Superior, Wisconsin.—The walk and stairway, 446 feet long, leading from the dwelling to the boathouse, was rebuilt, and various repairs were made.

—. *Chequamegon light and fog signal, Lake Superior, Wisconsin.*—The following statement made in the Board's last annual report is repeated:

The removing and rebuilding of the main light and the establishment of a harbor light and bell, at a cost not to exceed $10,000, were authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

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1269. Raspberry Island, Apostle Group, Lake Superior, Wisconsin.—This light was changed on the opening of navigation from a fixed white light varied by a white flash every 90 seconds to a fixed white light varied by a white flash every minute. The landing was extended by the addition of a crib. The boathouse was taken down and rebuilt adjoining the landing, on a foundation crib. New stairs were erected at the bank approaching the landing. Some 327 running feet of walk were relaid with new plank. Various repairs were made.

—. *Bayfield, Lake Superior, Wisconsin.*—The following statement made in the Board's last annual report is repeated:

The establishment of a light here, at a cost not to exceed $5,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

1270. Devils Island, Apostle Group, Lake Superior, Wisconsin.—The condemnation of this island for light-house purposes has at last been perfected, and the title to it is now in the Government. The following recommendation, which was made in the Board's annual report for last year, is therefore renewed:

The completing of the light-station here, at a cost not to exceed $22,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

NOTE.—An appropriation of $283.94 was made by the sundry civil appropriation act approved August 18, 1894, to pay the taxed costs in the matter of the proceedings in condemnation of Devils Island which was needed as a site for this light-house station.

1271. Sand Island, Apostle Group, Lake Superior, Wisconsin.—Some 357 running feet of plank sidewalk were relaid with new material.

1272. Superior Pierhead, Lake Superior, Wisconsin.—The keeper's dwelling was transferred from the Minnesota to the Wisconsin side of the entrance, and so arranged that each of the two keepers has six rooms. A sewer was laid from the rear of the dwelling to Allouez Bay. A boathouse was built on Allouez Bay with a landing. A drive well was sunk and the pump and pipe from the old site transferred. A barn was built, and a temporary kitchen was placed in the rear for the accommodation of the keeper during the construction of the work. Walks were built to the dock, boathouse, barn, etc., and to the well, and the walk on the pier from the light was extended inshore 100 feet, and the shore walk was continued to within 50 feet of the site. A fence was built, making an inclosure of the dwelling and outbuilding of 200 by 200 feet. A brick oil house was built, having a capacity of 360 gallons of oil. A steam fog signal was established and put in operation for the first time on October 15, 1893. It consists of duplicate locomotive boilers, 6-inch Scotch whistles, and automatic apparatus contained in a substantial building 20 by 40 feet, covered with corrugated iron, located on the south pier, in the rear of the beacon. The signal house was

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built under contract, and completed August 27, 1893. Various repairs were made.

1292. Duluth range, rear, Lake Superior, Minnesota.—A brick oil house was built and provided with a suitable shelving to store 360 gallons of oil. Various minor repairs were made.

1293. Two Harbors, Lake Superior, Minnesota.—A reversible hoisting engine of 20-horse power was set up in the fog-signal building and provided with necessary cable for hoisting the car for use in delivering fog-signal supplies. Various repairs were made.

1294. Grand Marais, Lake Superior, Minnesota.—The following statement made in the Board's last annual report is repeated:

A keeper's dwelling is needed at this station, but there is no land here belonging to the Government on which to build. There is an unexpended balance in the Treasury of $8,409.17 remaining of the appropriation made by act of March 3, 1885, "for completing the construction of a light-house at Grand Marais, Minn.," but the rulings of the accounting officers of the Treasury Department are such that this can not be used for the purchase of a site and erection of a keeper's dwelling. The land can be purchased and a suitable dwelling erected at an estimated cost not to exceed $8,400, and it is recommended that Congressional authority be obtained for using the balance of the above appropriation for this purpose.

—. Hat or Pats Point, near Grand Portage, Lake Superior, Minnesota.—The following statement made in the Board's last annual report is repeated:

The establishment of a light and fog signal here, at a cost not to exceed $15,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

REPAIRS.

More or less extensive repairs were made at each of the following stations during the year:

1136. Belle Isle, Mich.
1143. St. Clair Flats range, rear, Mich.
1146–1157. St. Clair River lights, Mich.
1160. Fort Gratiot, Mich.
1163. Sand Beach, east entrance, main light, Mich.
1167. Point aux Barques, Mich.
1170. Saginaw River range, rear, Mich.
1171. Charity Island, Mich.
1172. Tawas, Mich.
1174. Sturgeon Point, Mich.
1179. Presque Isle, Mich.
1182. Bois Blanc, Mich.
1184. Cheboygan, Mich.
1185. Cheboygan Crib, Straits of Mackinac, Mich.
1231. St. Marys Falls Canal, south pier, Mich.
1232, 1233. St. Marys River range, lower, Mich.
1236. Point Iroquois, Mich.
1238. Big Sable, Mich.
1239. Grand Island, Mich.
1240. Grand Island Harbor, Mich.
1245. Granite Island, Mich.
1246. Huron Island, Mich.
1247. Stannard Rock, Mich.
1250, 1251. Portage range, Mich.
1252. Manitou, Mich.
1254. Copper Harbor, Mich.
1255, 1256. Copper Harbor range, Mich.
1260. Eagle River, Mich.
1261. Portage Lake Ship Canal, Mich.
1264. Ontonagon, Mich.
1268. La Pointe, Wis.
1291. Duluth range, front, Minn.
1294. Grand Marais, Minn.
1295. Isle Royale, Mich.

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LIGHT-SHIPS.

1141. Grossepoint light-vessel, No. 10, Lake St. Clair, Michigan.—This vessel received some repairs to her hull before being put on her station in the spring.

1161. Lake Huron light-vessel, No. 61, at the foot of Lake Huron, Michigan.—This vessel was first placed in position in September, 1893. She is in good condition, well kept, and affords an excellent additional aid to navigation.

1183. Poe Reef light-vessel, No. 62, Straits of Mackinac, Michigan.—The following is extracted from the Board's annual report of last year:

> The establishment of a light-ship on this station, at a cost not to exceed $25,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

No direct appropriation was made for this purpose, but Congress authorized, in the sundry civil appropriation act approved August 5, 1892, "that the appropriation of $60,000 heretofore made in the act approved August 30, 1890, for establishing a light-station at or near Eleven-Foot Shoal, off Point Peninsula, Michigan, be applied under the direction of the Light-House Board, for the construction, or purchase and equipment, of one or more light-ships for service on the Great Lakes, and that said appropriation be immediately available for such ships." Thereupon three light-vessels were built from the appropriation named, one of which, No. 62, was placed off Poe Reef in September, 1893. She is in good condition and affords a much-needed aid to navigation.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

1160. Fort Gratiot, Mich.—This 8-inch steam whistle was in operation some 172 hours, consuming about 12 tons of coal.

1161. Lake Huron light-vessel, Michigan.—This 6-inch steam whistle was in operation some 83 hours, consuming about 4 tons of coal.

1163. Sand Beach (harbor of refuge) north main light, Michigan.—This 10-inch steam whistle was in operation some 130 hours, consuming about 17 tons of coal.

1168. Port Austin Reef, Michigan.—This first-class steam siren was in operation some 90 hours, consuming about 7 tons of coal.

1176. Thunder Bay Island, Michigan.—This 10-inch steam whistle was in operation some 266 hours, consuming about 18 tons of coal.

1179. Presque Isle, Michigan.—This 10-inch steam whistle was in operation some 365 hours, consuming about 26 tons of coal.

1180. Spectacle Reef, Michigan.—This 10-inch steam whistle was in operation some 234 hours, consuming about 11 tons of coal.

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1181. Detour, Mich.—This 10-inch steam whistle was in operation some 237 hours, consuming about 13 tons of coal.

1183. Poe Reef light-vessel, Michigan.—This 6-inch steam whistle was in operation some 83 hours, consuming about 5 tons of coal.

1184. Cheboygan, Mich.—This 10-inch steam whistle was in operation some 375 hours, consuming about 25 tons of coal.

1236. Point Iroquois, Michigan.—This 10-inch steam whistle was in operation some 407 hours, consuming about 24 tons of coal.

1237. Whitefish Point, Michigan.—This 10-inch steam whistle was in operation some 401 hours, consuming about 25 tons of coal.

1243. Marquette, Mich.—This 10-inch steam whistle was in operation some 224 hours, consuming about 14 tons of coal.

1246. Huron Island, Michigan.—This 10-inch steam whistle was in operation some 85 hours, consuming about 5 tons of coal.

1247. Stannard Rock, Michigan.—This 10-inch steam whistle was in operation some 144 hours, consuming about 9 tons of coal.

1252. Manitou, Mich.—This 10-inch steam whistle was in operation some 515 hours, consuming about 28 tons of coal.

1266. Outer Island, Wisconsin.—This 10-inch steam whistle was in operation some 237 hours, consuming about 14 tons of coal.

1268. La Pointe, Wis.—This 10-inch steam whistle was in operation some 315 hours, consuming about 21 tons of coal.

1270. Devils Island, Wisconsin.—This 10-inch steam whistle was in operation some 398 hours, consuming about 19 tons of coal.

1272. Superior Pierhead, Wisconsin.—This 6-inch steam whistle was in operation some 118 hours, consuming about 5 tons of coal.

1291. Duluth (front range), Minnesota.—This 10-inch steam whistle was in operation some 442 hours, consuming about 19 tons of coal.

1293. Two Harbors, Minn.—This 10-inch steam whistle was in operation some 613 hours, consuming about 42 tons of coal.

1296. Passage Island, Michigan.—This 10-inch steam whistle was in operation some 384 hours, consuming about 23 tons of coal.

BEACON AND POST LIGHTS.

St. Clair River beacon and range lights.—It was found necessary in the spring of 1894 to replace the old tin tubular lanterns with new brass lanterns, and these beacons are all now in good condition.

St. Marys River beacon and range lights.—The lights along the St. Marys River, from Pipe Island to the St. Marys Falls Canal, are kept by laborers, who are excellent men and perform their duties well. These lights are all in good condition, with the exceptions mentioned below. The front light at Winter Point (No. 1167) is now exhibited from the attic window of the keeper's dwelling, and the distance between the two lights is entirely too small to form a secure range. The tower from which the rear light is exhibited should be moved farther back.

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The tubular lanterns in use at many of the stations have been found to give much trouble and a poor light during freezing weather, and the substitution of lens lanterns is recommended. The crib for Lower Lake George (No. 1186) was turned over by the action of the ice last winter, and will have to be replaced. A temporary structure has been erected on the remains of the old crib, from which the light can be exhibited.

1188. Upper Lake George.—This crib has also been slightly moved and damaged by ice, but is still serviceable.

1203. Sault range (front), St. Marys River.—The plank walk from shore to light is in bad condition, and, as it is necessary, should be renewed.

Superior and St. Louis bays post lights, entrance to Duluth and Superior City harbors, Minnesota.—Eighteen post lights were established here in June, 1893. During the winter (1893-'94) nine of the pile clusters were destroyed by the ice and had to be renewed. Four others were damaged and had to be repaired. Since the opening of navigation, spring of 1894, two of the clusters have been much damaged by rafts, which are continually being towed through these bays, and it seems to be useless to attempt to maintain these lights unless more permanent structures are erected. Cribs, protected with sheet piling, are necessary to resist the action of the ice and to be secure against rafts. The Board recommends that an appropriation of $11,200 be made therefor.

BUOYAGE.

The buoyage was well looked after and no complaints were received. Requests for new buoys in the St. Marys River were examined into, and two new buoys were placed in position. A third-class can buoy was placed to mark a sunken wreck in the harbor of Presque Isle, Mich. Four buoys in Lake Huron were removed, being no longer necessary after the new light-vessels were placed in position.

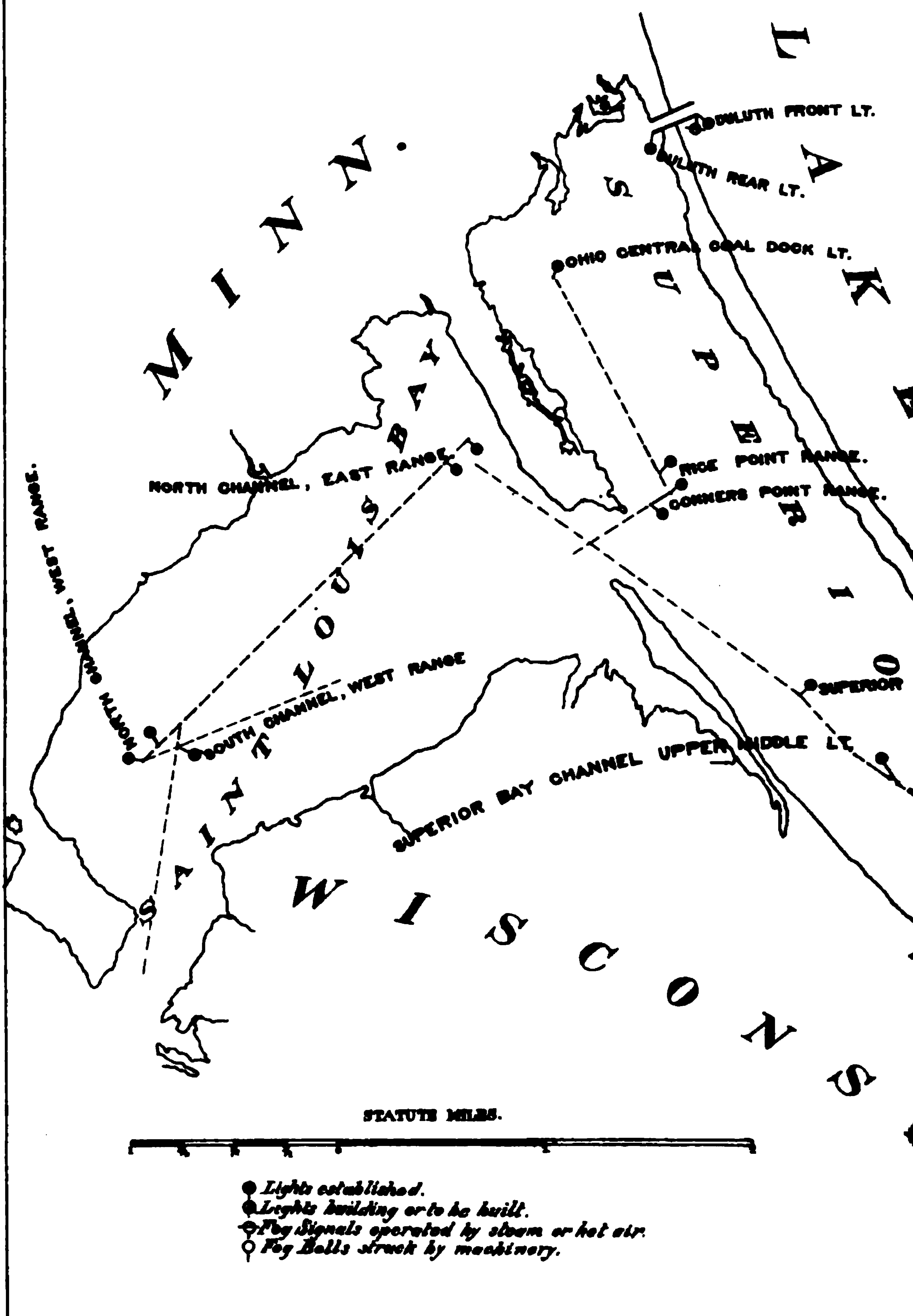
Rafts continue to give trouble in the St. Marys and Saginaw rivers, but the contractors for buoy service were able, by constant attention, to keep the buoyage of those rivers in a satisfactory condition.

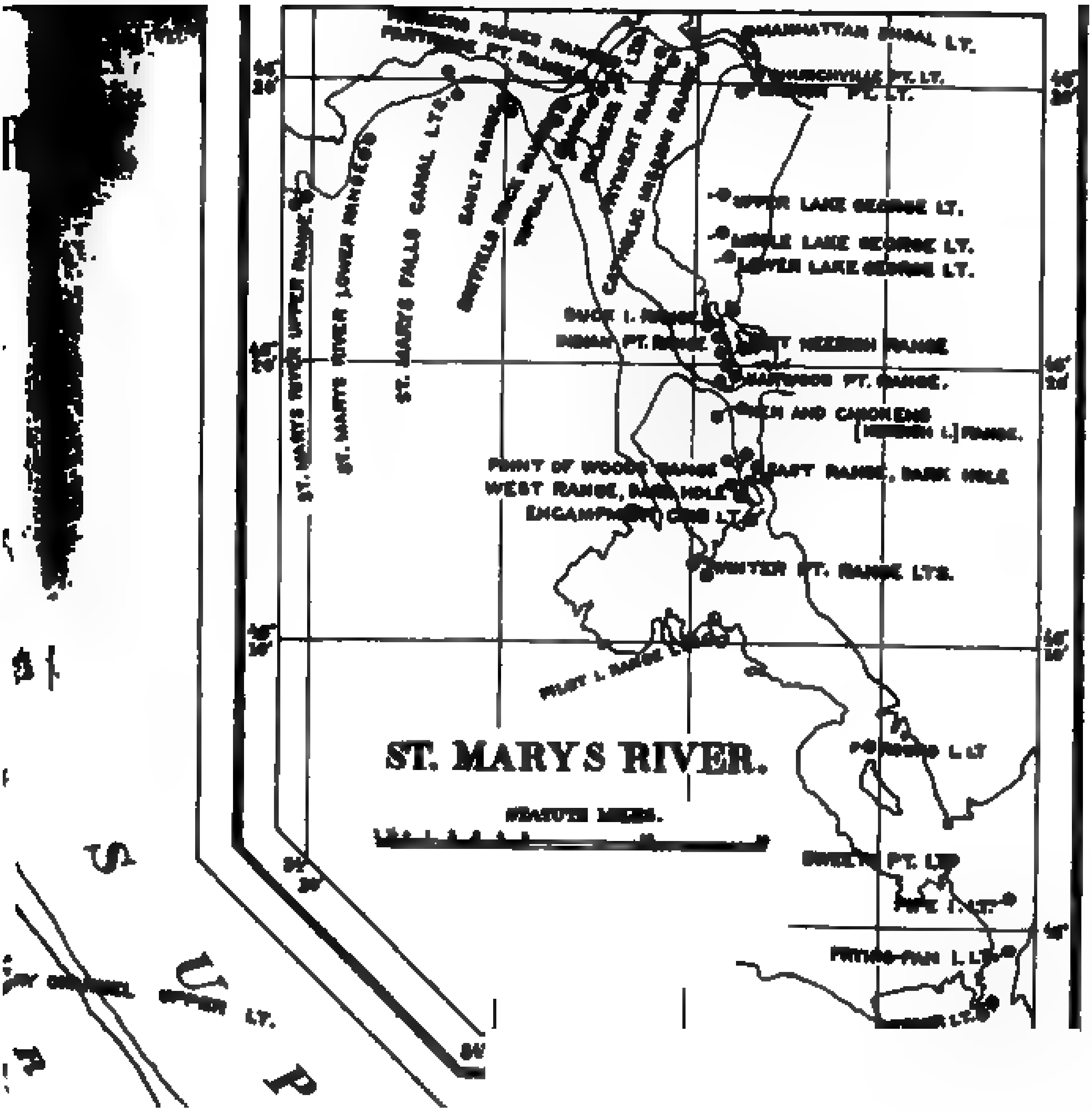
DEPOTS.

Detroit, Mich.—General repairs were made to the keeper's dwelling and the storehouse. The westerly bulkhead of the west slip was rebuilt a distance of 200 feet. Additional tracks were provided. The old track on the wharf was shifted from the center to one side, and a new track was laid on the other side, leaving room for a driveway between them. A new tramway was laid on the westerly side of the depot grounds, with a turntable and track connecting with that from Wight street. An iron gate was provided for one of the front entrances to the depot grounds on Wight street. The following recommendation, made in the Board's last annual report, is renewed:

ENLARGED PARTS OF
ELEVENTH L. H. DISTR

Corrected to June 30, 1894.





ST. MARYS RIVER.
STATUTE MILES.
MANHATTAN SHOAL LT.
UPPER LAKE GEORGE LT.
MIDDLE LAKE GEORGE LT.
LOWER LAKE GEORGE LT.
DUCK I. RANGE
INDIAN PT. RANGE
POINT OF WOODS RANGE
WEST RANGE,
WINTER PT. RANGE LTS.
ST. MARYS FALLS CANAL LTS.
ST. MARYS RIVER LOWER RANGES
ST. MARYS RIVER UPPER RANGE

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Mount Elliott avenue, a comparatively narrow street, leads from Jefferson avenue to the water front, past the marine hospital grounds and the grounds of the light-house depot. For convenience of shipment and temporary storage it is necessary that materials purchased for light-house constructions be delivered on the light-house grounds, and from time to time considerable delay and difficulty has occurred in consequence of the bad condition of Mount Elliott avenue. It is unpaved, while the hauling to and fro is considerable, the vicinity of the light-house depot being occupied by factories, foundries, and other industrial institutions of considerable magnitude, with lumber yards on the wharves.

Inquiries have been made of the city authorities with reference to the cost of having the street paved from Jefferson avenue to the limit of the light-house holding. Under the city ordinance the original paving of a street is at the cost of the adjacent property owners, divided pro rata according to the extent of their holding. The board of public works has immediate jurisdiction over these matters, and has reached the preliminary decision that the street, if paved, should be paved with brick or concrete. The width of the street is 24 feet, and the cost of paving in front of the light-house grounds with this material would be $960, and for the frontage of the marine hospital grounds $2,600, and the expense being divided between the fronting proprietors, the cost to the Light-House Service and the Marine-Hospital Service, respectively, would be one-half of these amounts.

As in the opinion of the Solicitor of the Treasury a special act of Congress authorizing the work is necessary, it is recommended that an appropriation of $2,000 be made, which is sufficient to cover the expense of the entire frontage of both the light-house and the marine hospital grounds.

TENDERS.

The Marigold.—This steamer is in good condition, with slight exception. She was almost constantly employed, during the season of navigation, on inspection and supply trips, coaling fog-signal stations, and in the care of buoys. In doing this work she steamed about 13,160 miles and consumed about 667 tons of coal.

The Warrington.—This steamer was out of commission and lying at the light-house depot wharf in Detroit.

The Lotus.—An addition of 20 inches to the shell of the boiler of this launch was made to convert it into one with submerged tubes. The upper portion of the launch over the boiler and engine rooms was housed in, the inclosure being carried aft; sleeping quarters were provided for two workmen, and a new steering wheel was constructed and placed in the forward part of the new house.

The Amaranth.—This steamer was employed during the season of 1893 and 1894 to June 30 in conveying the engineer on trips of inspection to St. Marys River lights and Lake Superior stations, conveying the engineer of the district and a board of officers to Bar Point light-ship to test the fog signals and inspecting the ship, and in delivering material required for repairs at Spectacle Reef, Grand Island Harbor, Stannard Rock, Manitou, Copper Harbor, Superior Pierhead, La Pointe, St. Clair Flats Canal, Presque Isle, Eagle Harbor, Eagle River, Passage Island, St. Clair Flats Canal (lower), Thunder Bay Island, Frying-Pan Island, Pipe Island and Detour light-stations, and in

Eleventh District.

returning materials from Spectacle Reef, Sand Point, Whitefish Point, Raspberry Island and Two Harbors light-stations, and taking workmen and material for the construction of the new Fourteen-Mile Point light-station, Michigan. She was put in winter quarters at the Detroit light-house depot wharf in November; the inside ironwork of the hull was scraped and painted, and various repairs were made. She was put in commission again in May, 1894. During the year she ran some 7,747 miles, and in doing so consumed about 602 tons of coal, which, added to her mileage in the Ninth district, makes a total of 9,810 miles, on a coal consumption of about 762 tons. In addition to this about 126 tons of coal were consumed by her in winter quarters, keeping steam for fire protection of the depot.

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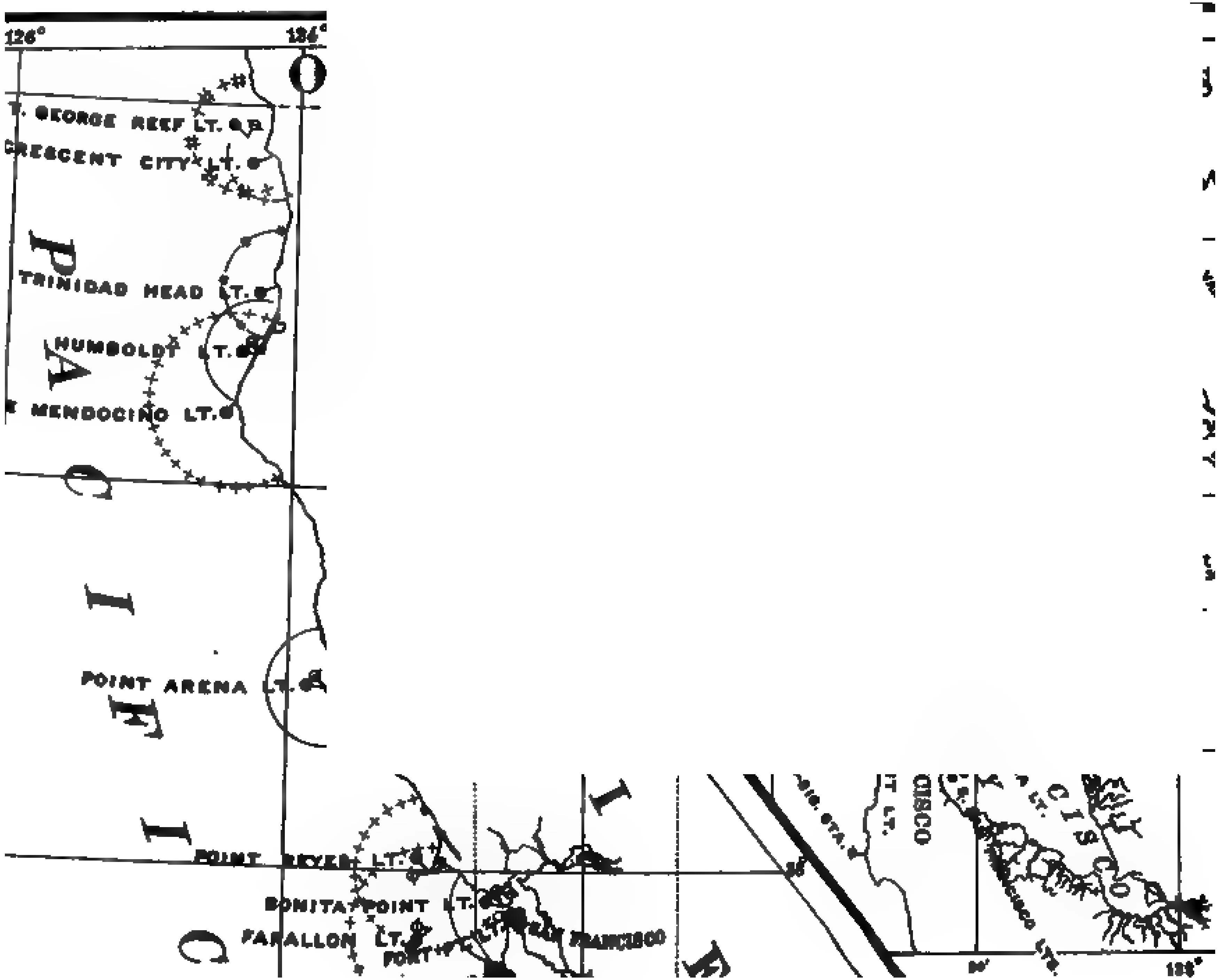

CRESCENT CITY LT.
TRINIDAD HEAD LT.
HUMBOLDT LT.
MENDOCINO LT.
POINT ARENA LT.
POINT REYES LT.
BONITA POINT LT.
FARALLON LT.
CISCO
P A C I F I C

TWELFTH DISTRICT.

This district extends from the boundary line between California and Mexico to the boundary between California and Oregon, a distance of about 800 miles of coast line, and embraces all the aids to navigation on the seacoast, bays, and navigable rivers of California.

Inspector.—Commander Henry E. Nichols, U. S. Navy.

Engineer.—Maj. William H. Heuer, Corps of Engineers, U. S. Army.

There are in this district:

Light-houses and lighted beacons, including 3 post lights	39
Day or unlighted beacons	54
Lighted beacons used also as day marks	7
Fog signals operated by steam	15
Fog signals operated by clockwork	8
Fog signals operated by hand	1
Whistling buoys in position	12
Bell buoys in position	6
Other buoys in position	79
Steamer *Madroño*, buoy tender, and for supply and inspection	1
Steam launch of *Madroño*	1
Steam launch *Hazel*	1

The aids to navigation in the Twelfth light-house district on July 1, 1894, are classified as follows:

First-order lights	9
Second-order light	1
Third-order lights	3
Fourth-order lights	10
Fifth-order lights	5
Lens lanterns	4
Tubular lanterns	7
Total	39

LIGHT-HOUSES.

864. Point Loma, entrance to San Diego Bay, California.—A brick oil house was built. Repairs were made to the water tanks. The color of the iron tower was changed to white with black lantern. A topographical survey of the site was made.

865. Ballast Point, San Diego Bay, California.—A topographical survey of the site was made.

870. Point Fermin, seacoast of California.—A topographical survey of the site was made.

871. Point Hueneme, entrance to Santa Barbara Channel, California.—A topographical survey of the site was made. Various minor repairs were made. As the efforts made to secure a right of way to and from this station for any reasonable price under the appropriation of $250

Twelfth District.

have failed, it is proposed, as was stated in the Board's last annual report, to obtain it by condemnation. It is estimated that this will cost not exceeding $3,000. It is recommended therefore, in view of the great necessity for the road, that an appropriation of $3,000 be made for this purpose.

—. *Deadman Island, at the outer end of the jetty on the east side of the entrance to San Pedro Harbor, California.*—The following recommendation, which was made in the Board's last four annual reports, is renewed:

The port of San Pedro, or Wilmington, is the seaport for Los Angeles. An enormous quantity of coal, lumber, and general freight is brought into this little harbor, which was made by breakwaters constructed by the United States. Deeply laden schooners discharge inside the harbor, while deep-water ships discharge into lighters out in the bay. It is necessary to use the tides in getting into this harbor, as there are but 12 feet of water on the bar at low tide. Fogs prevail at all seasons, and it is difficult to find the entrance at night or in foggy weather. It is recommended, therefore, that a harbor light and fog bell, operated by clockwork, be established on Deadman Island, at the entrance to this harbor, at an estimated cost of $5,000. This small island belongs to the Government, and is large enough for the purpose.

872. Santa Barbara, on the point 2 miles southeast of Santa Barbara Landing, California.—A galvanized iron windmill was erected over the well dug last year on a steel spider tower, a 5,000-gallon wooden cistern was put up on a substantial foundation, and pipe connections were made with the house and grounds. A topographical survey of this station was made. Various minor repairs were made. The light-house at this station was built in 1856. It is of brick with the outer wall stuccoed. The light is shown from an old-fashioned lantern with triangular-shaped glass, built on top of the dwelling. The structure is unsightly and uncomfortable, and in winter the walls are damp. To put this building in good repair would cost as much, if not more, than to build a new modern structure. This can be done, it is estimated, for not exceeding $7,500, and it is recommended that an appropriation of that amount be made therefor.

873. Point Conception, entrance to Santa Barbara Channel, California.—A topographical survey was made of this site. Various minor repairs were made.

—. *Point Arguello, about 12 miles northwest of Point Conception, seacoast of California.*—The following recommendation, which appeared in the Board's annual report for the last five years, is renewed:

This point is about 12 nautical miles to the northward and westward of Point Conception. It is reported to be one of the foggiest places on the Pacific coast. In consequence of the sharp bend in the coast, the outlying rocks, and the almost constant fog that prevails, Point Arguello is one of the most important points on the coast at which a light and fog-signal station should be established. The United States already owns the site which is deemed most suitable for the buildings. It is therefore estimated that the work can be done at a cost not to exceed $35,000, and it is recommended that an appropriation of this amount be made therefor.

874. San Luis Obispo, seacoast of California.—A topographical survey of this site and various minor repairs were made.

Twelfth District.

—. *Point Buchon, about 8 miles northwest from Point San Luis Obispo, California.*—The following recommendation, which was made in the Board's last five annual reports, is renewed:

This point is in San Luis Obispo County and is 17 miles distant from the town of San Luis Obispo by wagon road and trail. The nearest light-house is Piedras Blancas, about 30 nautical miles to the northward and westward. The point is prominent, and with its outlying rocks is very dangerous to navigators close inshore during a fog, especially as vessels going to and from Port Harford make a sharp turn just off this point. It is estimated that a light-house and fog signal can be erected at this point for $33,000.

875. *Piedras Blancas, entrance to San Simeon Bay, California.*—The old warehouse, which was in a dilapidated condition, was rebuilt. A new hoisting derrick was erected. The boom is of sufficient length to land material from a boat 15 feet off the wharf. A new landing was built on the site of the old one. A new electrical battery was put in and the wires were overhauled and put in good condition. A topographical survey of the station was made, as were various minor repairs.

876. *Point Sur, seacoast of California.*—A survey was made and a route was selected over the Sur ranch for the construction of the road from the light-house to the county road, about 3 miles in length. Bids for the construction of the road were invited; four were received; the lowest was accepted. The work is now in progress. Various minor repairs were made.

877. *Point Pinos, entrance to Monterey Bay, California.*—A fence, 5,090 feet in length, was built around the reservation. A topographical survey of the station was made, as were various repairs. The following recommendation, which was made in the Board's annual report for the last five years, is renewed:

The plot of land owned by the Government at this station does not touch the sea at any point on its boundary line. For convenience in landing stores and supplies it is essential that the United States should own the strip of land between the light-house lot and the seacoast. The owners have offered to sell the land desired for $2,000, and the Board recommends that an appropriation be made for its purchase.

879. *Año Nuevo Island, seacoast of California.*—The tramway leading from the landing to the signal was overhauled and repaired, 675 feet were renewed, and iron rails were put down. A turntable was put in at one point in order to dispense with a long curve, and thus shorten the track. A 4,500-gallon tank was erected. The trestle walk from the dwelling to the signal was rebuilt, and various minor repairs were made.

880. *Pigeon Point, extreme end of Pigeon Point, Pacific Ocean, California.*—There are standing outside of the light-house site, but close to the fence inclosing the light-house structures, a fisherman's shanty and a hay barn. If a fire should break out in either of these buildings it would endanger the structures of the light-station. It is proposed, in order to obviate this danger, that an additional strip of land to the

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eastward of the station, say 150 feet wide, be purchased and added to the light-house reservation. This, it is estimated, can be done for not exceeding $5,000, and it is recommended that an appropriation of this amount be made therefor.

882. Farallon, on southeast Farallon Islet, off the entrance to San Francisco Bay, Pacific Ocean, California.—A test was made to determine the relative merits of the steam sirens now in use and a steam whistle. This test was made by attaching a 10-inch steam whistle to one of the boilers, and blowing it and the siren alternately. At the same time observations were made at different points on the islands. The result showed that the steam whistle was by far the better signal for this station. Various repairs were made here.

883. Bonita Point, entrance to San Francisco Bay, California.—A new windmill, windmill tower, and pump were erected.

—. Quarry Point, Angel Island, San Francisco Bay, California.—The following recommendation, made in the Board's last two annual reports, is renewed:

Various petitions were received from those representing marine interests, asking that a fog signal be established at this point. The passage between the eastern side of Angel Island and Southampton Shoal is quite narrow. The strong tides setting in and out through the Golden Gate have full force on a vessel bound up or down the bay, and in the case of ships being towed, as so many are past this point, the set of the current is enough to make it hazardous, there being danger either of running aground on Southampton Shoal or Angel Island. An enormous quantity of shipping annually passes this point, bound to and from the great grain wharves at Port Costa, the Sacramento and San Joaquin rivers, and Mare Island Strait. Hundreds of the largest sailing ships are towed from San Francisco to Port Costa, where they load with grain and are then towed down and out to sea. In this way there is more shipping passing through these waters than anywhere else in the district except through the Golden Gate. There have been a number of casualties in the vicinity of this point. Among many were the following:

The ferry steamer *Contra Costa*, plying between San Francisco and San Quentin with passengers, ran ashore near California City.

The ship *E. B. Sutton*, while being towed down from Port Costa, ran ashore near Quarry Point, Angel Island.

The ship *Eleanor Margaret*, bound to Port Costa, ran ashore on Bluff Point, Raccoon Straits.

The ship *Maulsden*, while being towed to Port Costa, ran ashore on Southampton Shoal.

Mariners have asked that Quarry Point be selected for the fog-signal station, because, to make a start up river in a fog, it is necessary to make Angel Island to get a departure. After careful examination the Board reached the conclusion that a fog signal at this locality would be a decided aid to mariners. In view of the great economy of establishing and maintaining a large fog bell here instead of a steam fog signal, it decided in favor of the former. It is estimated that it will cost $6,000 to establish this fog bell, and it is recommended that an appropriation of this amount be made therefor.

891, 892. South San Francisco range, San Francisco Bay, California.—This channel is principally used at night. Both beacons showed a white light. The outer one was apt to be confused with the lights of fishing

Twelfth District.

vessels anchored near; hence the color of the outer light was changed from white to red.

889. *Oakland Harbor, entrance to Oakland Harbor, California.*—The stability of the piles supporting this structure was increased and further oscillation was prevented by filling the space under the building with 2,000 tons of stone. This was quarried on Goat Island and was transported to the station in schooners. The depth of water being 13 feet, the slope of the rock filling carried the footings out so far the boats could not readily land at the existing steps. The difficulty was overcome by extending a platform from the gallery out over the rock and putting up a new ladder.

893. *East Brother Island, entrance to San Pablo Bay, California.*—The old unsafe landing wharf was removed and a new one was built. The new wharf is 60 feet long by 20 feet wide, supported on paraffin-coated steel-shod piles driven about 10 feet into a rock bottom. New boat ways were built. Various repairs were made.

—. *New York Slough, entrance to San Joaquin River, California.*—The following statement made in the Board's last annual report is repeated:

The establishment of a light and fog signal here, at a cost not exceeding $10,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

899. *Point Reyes, on the western extremity of Point Reyes, Pacific Ocean, California.*—A speaking tube 265 feet long was put up, thus connecting the tower with the fog signal.

—. *Bodega Head, between Point Arena and Point Reyes light-stations, seacoast of California.*—The following recommendation, made in the Board's last five annual reports, is renewed:

It is recommended that a fog-signal station be established at Bodega Head, coast of California, a point 18½ miles to the northward of Point Reyes and 49 miles to the southward of Point Arena. The stretch of coast between Point Reyes and Bodega Head is the scene of many wrecks, due to foggy weather and uncertain currents. Vessels coming down from the north, bound to San Francisco, pass close enough to Point Arena to either see the light or to hear the fog signal there and take a new departure for Point Reyes. The coast line is generally straight as far down as Bodega Head; a fog-signal station at this point would give sufficient warning to vessels which have unconsciously got in there to enable them to haul out in time to weather Point Reyes. It would be a great aid to vessels going into Bodega and Tomales bays, as well as to those going into the landings and lumber chutes immediately above Bodega. Owing to the configuration of the land and other causes, it is extremely difficult to hear the Point Reyes signal anywhere to the northward of the point. Fog, accompanied by northwest winds, varying from fresh to strong in force, prevails above Point Reyes during about nine months of the year. The currents are uncertain in direction either up or down the coast, and seem to be due to causes which exist far to the north. It has been noticed that indrafts prevail off the indentations in the coast, and the current close inshore runs in an opposite direction to what it does outside the headlands. The water is usually so deep in the regular routes up and down the coast that little, if any, use is made of the hand lead. A fog signal at this locality would therefore be of great benefit to mariners, and a small

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light would also be of much service, at little additional expense, as there is a stretch of unlighted territory about 68 miles in length between Point Reyes and Point Arena. The Government owns no land at Bodega; but 2 or 3 acres would be sufficient for the station, and could probably be bought for $1,000. An engine house, such as is being constructed at San Luis Obispo, with duplicate steam fog-signal whistles, and two single dwellings for the keepers, one to have a tower for the light, as at San Luis Obispo, the other for the assistant keeper, similiar to the new one designed for Point Loma light-station, with coal shed, oil house, outhouses, etc., will probably suffice to establish the station. These, it is estimated, will cost $30,000, and it is recommended that an appropriation of this amount be made therefor.

901. Cape Mendocino, on the western extremity of Cape Mendocino, California.—The following statement made in the Board's last annual report is repeated:

An appropriation of $500 was made in the sundry civil appropriation act approved August 5, 1892, for the purchase of the right of way for a road to this station, but it is insufficient for the purpose, as the cost of establishing the road is estimated to be $1,000. It is therefore recommended that a further appropriation of $500 be made.

—. Punta Gorda, between Shelter Cove and Cape Mendocino, seacoast of California.—The following recommendation, which was made in the Board's last five annual reports, is renewed:

Between Shelter Cove and Punta Gorda there are several dangerous sunken rocks off the shore that add to the hazards of navigation. In ordinary dark nights the overhanging mountains keep the shore line in dark shadow and confuse the best navigator as to his distance from shore, so that it is impossible to make out this high rounding point, either from the south or from the north. Moreover, from reports made to the Coast and Geodetic Survey, it appears that little is known as to the currents of this part of the coast. The conclusion is reached, therefore, that the interests of commerce and navigation require that a light and fog signal be established at or near Punta Gorda, Cal. It is estimated that the work will cost $40,000.

903. Trinidad Head, on Trinidad Head, Pacific Ocean, California.—A topographical survey of this station and various repairs were made.

905. St. George Reef, on Northwest Seal Rock, off Crescent City, seacoast of California.—The light-house inspector landed on the rock several times during the year. In January last a new standard 18-foot boat was supplied. This was made necessary by the loss of the first assistant keeper on October 17, 1893, together with the standard boat then at the station. No vestige of man or boat has been discovered. A set of boat davits were put up on a wharf at Crescent City to enable the light-keepers to secure their boat while they are on shore.

REPAIRS.

During the fiscal year repairs and renovations more or less extensive were made at the following-named stations:

880. Pigeon Point, Cal.
881. Point Montara, Cal.
885. Lime Point, Cal.
886. Angel Island, Cal.
887. Alcatraz, Cal.
888. Yerba Buena, Cal.
894. Mare Island, Cal.
900. Point Arena, Cal.
901. Cape Mendocino, Cal.
902. Humboldt, Cal.
904. Crescent City, Cal.

Twelfth District.

DAY OR UNLIGHTED BEACONS.

These beacons have received such attention as was necessary and practicable during the year.

LIGHTED BEACONS USED ALSO AS DAY MARKS.

These beacons have been cared for during the year. The red lens lantern at Oakland Harbor South Jetty beacon was established and the light was first shown on September 15, 1893. The Oakland Harbor rear range light was discontinued on that date.

FOG SIGNALS OPERATED BY STEAM.

873. Point Conception, California.—The 12-inch steam whistles, in duplicate, were in operation some 246 hours, and consumed about 31 tons of coal.

874. San Luis Obispo, Cal.—The 10-inch steam whistles, in duplicate, were in operation some 1,364 hours, and consumed about 78 tons of coal.

876. Point Sur, California.—The 12-inch steam whistles, in duplicate, were in operation some 1,048 hours, and consumed about 96 cords of wood.

879. Año Nuevo Island, California.—The 12-inch steam whistles, in duplicate, were in operation some 847 hours, and consumed about 50 tons of coal.

880. Pigeon Point, California.—This signal, consisting of one 10-inch and one 12-inch steam whistle, was in operation some 987 hours, and consumed about 83 cords of wood.

881. Point Montara, California.—The 12-inch steam whistles, in duplicate, were in operation some 658 hours, and consumed about 79 cords of wood.

882. Farallon, California.—The first-class steam siren, in duplicate, was in operation some 1,360 hours, and consumed about 69 tons of coal.

883. Bonita Point California.—The first-class steam siren, in duplicate, was in operation some 1,555 hours, and consumed about 111 tons of coal.

885. Lime Point, California.—The 12-inch steam whistles, in duplicate, were in operation some 1,061 hours, and consumed about 95 tons of coal.

888. Yerba Buena, California.—The 10-inch steam whistles, in duplicate, were in operation some 200 hours, and consumed about 15 tons of coal.

893. East Brother Island, California.—The 12-inch steam whistle was in operation some 178 hours, and consumed about 13 tons of coal.

899. Point Reyes, California.—The 12-inch steam whistles, in dupli-

THIRTEENTH DISTRICT.

This district extends from the southern boundary of Oregon to the boundary line between the United States and British Columbia, and embraces all the aids to navigation on the Pacific coast of Oregon and Washington, and the Columbia and Willamette rivers, Strait of Juan de Fuca, Puget Sound, and Alaskan waters.

Inspector.—Commander Oscar W. Farenholt, U. S. Navy.

Engineer.—Maj. Thomas H. Handbury, Corps of Engineers, U. S. Army, to November 30, 1893; Maj. James C. Post, Corps of Engineers, U. S. Army, from February 19, 1894.

There are in this district—

Light-houses and beacon lights, including 80 post lights	108
Light-ships in position	1
Day or unlighted beacons	37
Fog signals operated by steam or hot-air engines	10
Fog signals operated by clockwork	3
Whistling buoys in position	9
Bell buoys in position	4
Other buoys in position	256
Steamer *Manzanita*, buoy tender, and for supply and inspection	1
Steamer *Columbine*, buoy tender, and for supply and inspection	1

LIGHT-HOUSES.

907. *Coquille River, at the mouth of Coquille River, seacoast of Oregon.*—A deed of the land was obtained and a survey of the site was made. Drawings and specifications are being prepared. When these are completed bids will be asked to construct the station.

908. *Cape Arago, on a small island at the western end of Cape Arago, seacoast of Oregon.*—The following statement made in the Board's last annual report is repeated:

> The commerce of these waters would be greatly benefited by placing a firs fog signal on the point of the island on which this light is located. It is esti that this fog signal can be established for not exceeding $5,500.
>
> The light-keepers' dwelling at this station was erected in 1866. It was built and ill adapted to accommodate the two keepers, with their families; it and decayed and on the verge of collapse. If a fog signal is erected here, still ai keeper will be needed, and his family will need quarters. It is estimated ı double set of quarters, similar to those recently erected at Turn Point and Islands light-stations, can be built here for not exceeding $10,000.
>
> By the act approved March 3, 1891, $50,000 were appropriated for the esta ment of a light and fog signal at the mouth of the Coquille River, Oregon. It ı found that it can be done for a much less sum. It is therefore recommende

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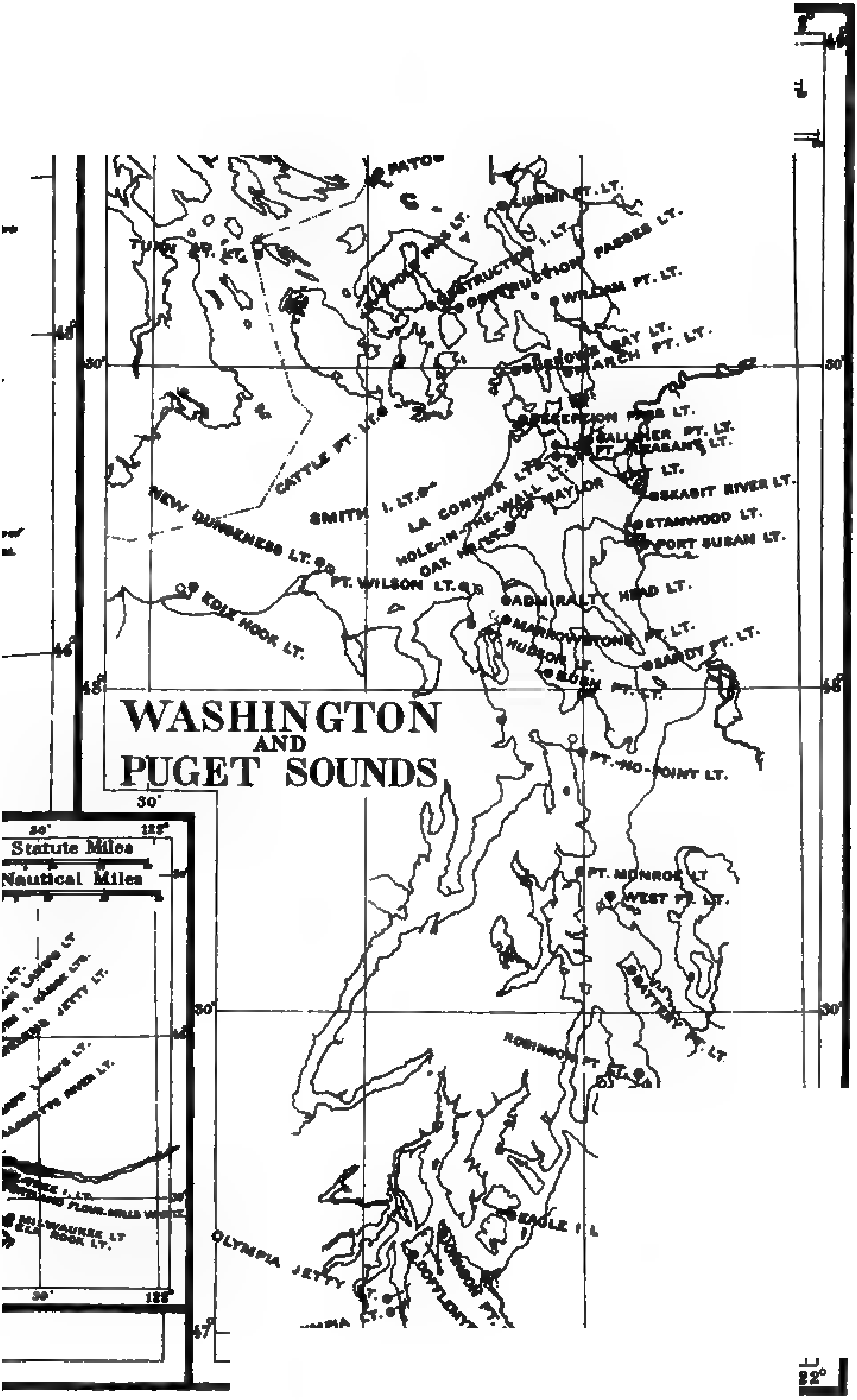
WASHINGTON
AND
PUGET SOUNDS
Statute Miles
Nautical Miles
TURN PT. LT.
CATTLE PT. LT.
SMITH I. LT.
NEW DUNGENESS LT.
EDIZ HOOK LT.
PT. WILSON LT.
LA CONNER LT.
HOLE-IN-THE-WALL LT.
OAK HARBOR
ADMIRALTY HEAD LT.
MARROWSTONE PT. LT.
HUDSON PT.
BUSH PT. LT.
SANDY PT. LT.
SKAGIT RIVER LT.
STANWOOD LT.
PORT SUSAN LT.
PT. NO POINT LT.
PT. MONROE LT.
WEST PT. LT.
ROBINSON PT. LT.
OLYMPIA JETTY
EAGLE I. L.
PT. PLEASANT LT.
GALLAGHER PT. LT.
DESTRUCTION I. LT.
WILLIAM PT. LT.
MILWAUKEE LT.
EDIZ HOOK LT.

Thirteenth District.

the Light-House Board be authorized to expend not exceeding $15,500, from the appropriation for establishing a light and fog signal at the mouth of the Coquille River, in erecting light-keepers' dwellings and a fog signal at Cape Arago light-station.

NOTE.—The authority asked was granted in the sundry civil appropriation act approved August 18, 1894, in the following words:

That $15,000 of the remaining balance of the sum appropriated by the act approved March 3, 1891, for the establishment of a light and fog signal at the mouth of the Coquille River, Oregon, be used in the erection of light-keepers' dwellings and a fog signal at the Cape Arago light-station.

909. Umpqua River, seacoast of Oregon.—The following statement made in the Board's last annual report is repeated:

The contractor for the erection of the tower at this station completed his work on August 30, 1892. The contractor for the erection of the dwellings, barn, etc., completed his work on January 14, 1893. Since January 19, 1893, the station has been in charge of a watchman. The lens and illuminating apparatus for this tower are at the station. When an attempt was made to put these in place it was found that the stand which supports the lens was not of the proper height and would need the addition of a base to raise the lens about 15 inches. The estimated cost of the work and material absolutely necessary to exhibit the light is $200. The estimated cost of completing the station is not exceeding $2,400. There are no funds available for this work, the whole of the appropriation having been expended. There is pay due the watchman from May 1 to June 30, 1893, at the rate of $60 per month. This financial status results from the failure of the original contractors for the erection of the keepers' dwelling, barn, etc., to carry out their contract of September 17, 1891, which caused the reletting of the work, at additional cost, as set forth in the last annual report. There is now due $2,371 from their bondsmen. The U. S. Attorney-General has the matter in hand, with the view to the collection of this amount from these bondsmen. Meantime, however, this amount is needed to pay the new contractors.

This station remains unfinished and is guarded by a watchman. The suit against the defaulting contractors for $2,371 is still pending. When this suit is ended the amount recovered can be covered into the Treasury to replace the amount appropriated.

NOTE.—An appropriation of $2,371 was made in the sundry civil appropriation act approved August 18, 1894. The station will now be finished and lighted as soon as practicable.

910. Heceta Head, mouth of Siuslaw River, between Cape Arago and Cape Foulweather, seacoast of Oregon.—The tower at this station was completed by the contractors August 31, 1893; the lens and supplies were landed at the station in October and set up in November and December. Owing to a delay in receiving the lamps from the general light-house depot at Staten Island, New York, they were not delivered at the station until February, 1894, and the light was first exhibited March 30, 1894.

—. *Yaquina Bay, Oregon.*—The following recommendation made in the Board's last four annual reports is renewed:

Vessels now have occasion to pass in and out of the bay during the night, and lights are needed to prevent accidents. During a part of the year the mail has to be

Thirteenth District.

carried before daylight in the morning and after dark at night. The necessities of commerce in this locality are such as to demand the establishment of inexpensive lights at this point. It is estimated that they could be established at a cost of about $300.

The Board proposes, when funds are available, to establish two inexpensive beacon lights at the mouth of the bay, and to pay therefor from the general appropriation for repairs, etc., of light-houses, which provides for such expenditures.

912. Cape Meares, south of Tillamook Bay, seacoast of Oregon.—Work was commenced on a wagon road leading from the station to the Tillamook River, where it was to connect with a ferry and road leading into Tillamook City. The work was done by hired labor and the purchase of materials in open market, and was pushed vigorously until November 20, when funds were exhausted. The road was opened to an unfinished county road which continues to the Tillamook River, distant about 1½ miles. It also connects with the Netarts Bay road, so the station is now also accessible to wagons from Tillamook City by that route.

—. *Willamette River light-station, at the mouth of the Willamette River, Oregon.*—The following statement made in the Board's last annual report is repeated:

The establishment of a light and fog-signal station here, at a cost not exceeding $6,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

NOTE.—An appropriation of $6,000 for the establishment of this light-station was made by the sundry civil appropriation act approved August 18, 1894. The work will be taken in hand at an early day.

966. Cape Disappointment, seacoast of Washington.—The following statement, made in the Board's last annual report, is repeated:

The establishment of a first-order light at North Head, at a cost not exceeding $50,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made.

NOTE.—The following is an extract from the sundry civil appropriation act approved August 18, 1894:

Toward establishing a first-order light on North Head, Cape Disappointment, seacoast of Washington, twenty-five thousand dollars, and the total cost of said light, under a contract which is hereby authorized therefor, shall not exceed fifty thousand dollars.

The Board now recommends that $25,000 be appropriated for completing this light-station.

968. Grays Harbor, seacoast of Washington.—The following statement, made in the Board's last annual report, is repeated:

By act of Congress approved March 3, 1893, an appropriation of $20,000, in addition to the $15,500 previously appropriated, was made to establish a first-order light and fog-signal station; and it was further provided that a contract may be made for this work at a total cost not to exceed $75,000. The location of this station had not been definitely determined at the end of the year. Plans of the necessary structures are being prepared.

Thirteenth District.

The establishment of a light and fog signal here, at a cost not exceeding $75,000, was authorized by the act approved February 15, 1893, while appropriation for but $35,500 therefor has yet been made. The Board recommends that the balance, $39,500, be appropriated for the completion of this work.

A site for the light-station has been selected, surveyed, and approved. Negotiations are now pending for the acquisition of a title to the needed land.

969. *Destruction Island, seacoast of Washington.*—The boathouse was completed and the water tank for the engine at the landing was put in place. The inclined tramway from the boat landing to the top of the bluff having become unsafe, a new one was built on an easier grade; also a new car for conveying supplies. The size of the main sewer leading from the dwellings proving insufficient, a larger one was substituted. The accumulation of water from the heavy rains about the dwellings rendered extensive drainage necessary, and this work is now in progress. A workroom is about to be built adjoining the tower, to aid in keeping the interior of the latter dry.

970. *Cape Flattery, on Tatoosh Island, entrance to the Strait of Juan de Fuca, Washington.*—The crowded condition of the double dwelling made it an urgent necessity to put the dwelling attached to the tower in a condition suitable for occupancy. This building, constructed in 1857, was built of stone. The woodwork, which was in an advanced state of decay, was entirely renewed, and the building is now habitable. The following recommendation, made in the Board's last six annual reports, is renewed:

It was decided that the location of the fog signal ought to be changed to West Island, as it could be heard from the latter point much more distinctly by passing vessels. This change of location, it is estimated, will cost $17,000, and it is recommended that appropriation be made accordingly.

971. *Ediz Hook, Strait of Juan de Fuca, Washington.*—A new oil house of galvanized iron was built and various repairs were made.

972. *New Dungeness, Strait of Juan de Fuca, Washington.*—A new boiler was supplied and connections were made with the engine, boiler, and cisterns. The boathouse was moved about 1,000 feet to avoid the drift which accumulated upon and obstructed the boat ways. A new oil house of galvanized iron was put up, and a new foot walk was built to connect the boathouse with the dwelling.

974. *Point Wilson, Admiralty Inlet, Washington.*—The old boiler of the fog signal was put in temporary repair, and a new return tubular boiler was purchased. A galvanized-iron oil house was erected. A new lens with revolving apparatus was substituted in the tower for the old one. Various repairs were made.

977. *Marrowstone Point post light, Admiralty Inlet, Washington.*—A survey was made of the proposed site, and plans and specifications of the buildings are being prepared.

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978. Point No Point, Puget Sound, Washington.—The boat ways were rebuilt. The sewer from the dwelling was extended and a few small repairs were made. It appears that the present fog bell at Point No Point does not satisfy the needs of the service. It is recommended, therefore, that a first-class fog signal be installed in place of the bell. It is estimated that this can be done for $6,000, and the Board recommends that an appropriation of this amount be made therefor.

982. Robinson Point, Puget Sound, Washington.—The lens lantern was partially obscured by the dwelling, and to overcome this fault the light was raised about 5½ feet. Some 200 cubic yards of stone were deposited in front of the bulkhead in the vicinity of the fog signal to prevent the seas from cutting away the grounds.

1011. Turn Point, west end of Stuart Island, Canal de Haro, Washington.—The contractors completed the dwellings, fog-signal buildings, etc., at this station in July, 1893, and the fog-signal machinery was ready for operation in October. A suitable sailboat was built and delivered for the use of the keepers, a boathouse was built, foot walks were laid, and the station was put in good order. This station was put in operation November 30, 1893.

1012. Patos Islands, entrance to Canal de Haro, Washington.—The fog-signal apparatus was set up in October, 1893, and was put into operation on November 30, 1893. Experiments were made to test the fog signal, and it was found to be deficient in strength. New reeds were tried, but a trumpet of additional length is needed. A suitable sailboat was furnished for the keepers' use, and a boathouse with boat ways was built. Foot walks, outhouses, etc., were made.

—. *Mary Island light-station, Alaska.*—The following statement, made in the Board's last annual report, is renewed:

> A custom-house has been established here; hence many vessels are obliged to make this a place of call. A small, inexpensive light, say a lens-lantern beacon, would assist vessels to make the port at night and hold on. The beacon could be kept by one of the custom-house employés. It is estimated that it could be established and maintained a year for $800, and it is recommended that an appropriation of that amount be made for this purpose.

—. *Post lights in Puget Sound and its adjacent waters, and the Columbia and Willamette rivers.*—These lights are efficient aids to navigation in the inland waters of this district. Five new ones were established during the year, and two were discontinued. Several were changed to more advantageous positions. All the lights were inspected during the year; the keepers did their work well.

The post lights in the Columbia and Willamette rivers, in Puget Sound and in adjacent waters, are of great benefit to navigation, and night boats now run regularly on the Columbia and Willamette rivers. They are of much use during fog, as the lights can be seen, except in very dense fogs, at a distance of 100 yards or more, and the pilots rely

on the lights for a new departure. Without their aid night boats could not run regularly. The demand for these lights on Puget Sound and its tributary rivers is increasing with the growing commerce. The Board recommends, therefore, the establishment of thirty post lights along the navigable channels of the Snohomish River, the Skagit River, the Nooksack River, and the La Connor Slough, and along such other channels of Puget Sound and the rivers tributary thereto, in the State of Washington, as may be necessary to meet the requirements of commerce.

It is estimated that this will cost not to exceed $4,200, and the Board recommends that an appropriation of this amount be made therefor.

—. *Willamette River post lights, Oregon.*—The following statement, made in the Board's last annual report, is repeated:

The establishment of beacon lights and buoys at 25 different points between the cities of Salem and Portland, Oreg., at a cost not exceeding $5,000, was authorized by the act approved February 15, 1893, but no appropriation therefor has yet been made. The Board recommends that the amount named be appropriated.

REPAIRS.

Repairs were made at the following-named stations:

906. Cape Blanco, Oreg.
913. Tillamook Rock, Oreg.
915. Point Adams, Oreg.
967. Willapa Bay, Wash.
973. Smith Island, Wash.
975. Admiralty Head, Wash.
980. West Point, Wash.

LIGHT-SHIPS.

914. Columbia River light-vessel No. 50, off the Columbia River Bar, Washington.—The lights, fog signal, etc., are in good order. The ship has been on her station since April, 1892.

—. *Umatilla Reef light-vessel, Pacific Ocean, off the Strait of Juan de Fuca, Washington.*—The following recommendation, made in the Board's last annual report, is renewed:

The steamer *Michigan* was wrecked in January, 1893, by striking on Umatilla Reef, which is just off Flattery Rocks, coast of Washington, and is some 30 miles south of Bonilla Point, off the southwest coast of Vancouver Island, which lies like a bar across the course of northward-bound vessels. Although no lives were lost by the wreck of the *Michigan*, both vessel and cargo were destroyed. This wreck has called renewed attention to the fact that since our vessels have been sailing on this coast some thirty have been lost in running northward for the entrance to the Strait of Juan de Fuca. The coast of Washington, north of Point Greenville, is quite dangerous because of the great number of outlying rocks and the low-lying land of the neighboring coast. At latitude 48° 10′ the Flattery Rocks extend farther westward than any point of the coast of California, Oregon, or Washington, and being to the westward of the Cape Flattery light, on Tatoosh Island, which is only 13 miles to the northward, they are the greatest danger to navigation on the northern coast. In thick, stormy, winter weather, a vessel bound north, with a departure from Cape Orford light, can run 320 miles without a check, and must for safety's sake keep off from the very coast she wishes to make. As little if anything is known

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of the set of the currents near the great inlet of the Strait of Juan de Fuca, a vessel when in those waters may be largely in error as to her position; hence she takes a great risk in running to the eastward when her "distance is up" as to time; and yet this has to be done when steamers are making schedule time. It is difficult and dangerous to attempt to find the entrance to the strait in fog, and fog prevails there to a large extent. The *Fauntleroy* lay off that entrance once for seven days in a heavy southeaster and densely thick weather, not daring to attempt to make the entrance. The densest and blackest fogs of that foggy coast hang about the mouth of the strait.

Vessels bound to the northward do not voluntarily go near enough to the shore to hear the whistling buoy off Flattery Rocks. The coast from Umatilla Reef to Tatoosh Island, a distance of 13¼ miles, is full of rocky islets and submerged dangers. The currents are strong and uncertain, and have a trend toward the shores which lie both to the northward and eastward. From various causes vessels fail to hear the steam fog signal at Tatoosh Island light-station, and hence are uncertain as to whether or not they have arrived off the entrance to the Strait of Juan de Fuca.

A light-ship with a steam fog signal, if anchored in some 30 fathoms of water, off Umatilla Reef of the Flattery Rocks, would enable vessels to take a clean departure and make the entrance to the strait and to clear Duncan and the Duntzé rocks which are marked by the red ray of Cape Flattery light. It is estimated that a proper light-vessel, one with steam motive power, which could take care of herself in case she was torn from her moorings, and one with the most powerful steam fog signal could be built and placed there for not exceeding $80,000, and it is recommended that an appropriation of this amount be made therefor.

DAY OR UNLIGHTED BEACONS.

The day beacons in this district were thoroughly repaired and in many cases they were rebuilt. The spindle on Lincoln Rock, Clarence Strait, Alaska, was removed and replaced by a first-class nun buoy.

FOG SIGNALS OPERATED BY STEAM OR HOT-AIR ENGINES.

913. *Tillamook Rock, Oregon.*—The first-class siren, in duplicate, was in operation some 316 hours and consumed about 16 tons of coal.

914. *Columbia River light-vessel No. 50, Washington.*—The 12-inch steam whistle was in operation some 802 hours and consumed about 71 tons of coal.

969. *Destruction Island, Washington.*—The first-class steam siren, in duplicate, was in operation some 825 hours and consumed about 49 tons of coal.

970. *Cape Flattery, Washington.*—The 12-inch steam whistle, in duplicate, was in operation some 520 hours and consumed about 32 tons of coal and about 100 feet of wood.

972. *New Dungeness, Washington.*—The 12-inch steam whistle was in operation some 244 hours and consumed about 12 tons of coal.

974. *Point Wilson, Washington.*—The 12-inch steam whistle was in operation some 157 hours and consumed about 16 tons of coal.

980. *West Point, Washington.*—The Daboll trumpet was in operation some 195 hours and consumed about 2 tons of coal and about 76 feet of wood.

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982. Robinson Point, Washington.—The 12-inch steam whistle was in operation some 56 hours and consumed about 5 tons of coal.

1011. Turn Point, Washington.—The Daboll trumpet was in operation some 54 hours and consumed about 1 ton of coal.

1012. Patos Islands, Washington.—The Daboll trumpet was in operation some 90 hours and consumed about 1 ton of coal.

BUOYAGE.

The buoyage in this the largest district regarding coast line and inland waters, is in excellent condition. This efficiency could not have been reached with one tender. Two are absolutely necessary. It must be borne in mind that during stormy winter weather the tenders at times are bar-bound at Astoria for weeks, and unable to work on this rough, boisterous coast. With the exception of the buoys in the Upper Columbia and Willamette rivers, every buoy is in place and was changed during the year; some of the most important ones, when necessary, were changed three to four times. The exceptionally severe heavy coast gales and the unprecedented June floods, higher than ever known, were very destructive to the coast and river buoyage. Seven whistling buoys went adrift, 2 of which were recovered. During the year 27 buoys of various classes were recovered on the ocean beach from Cape Blanco to Cape Flattery. The heavy floods of the Columbia and Willamette rivers, with the driftwood, swept out every buoy and many light stakes from Harrington Point to Portland, a distance of 80 miles. As soon as the water falls these two rivers will be sounded out, and buoys will be established in the newly formed channel. In June, 1894, 3 buoys in Alaskan waters were changed to a larger size, and 7 new buoys were established.

BELL BUOYS IN POSITION.

Wreck of the Great Republic, Columbia River, Washington.—A first-class bell buoy in good condition.

South side of channel, Columbia River, Washington.—A first-class bell buoy in good condition.

Point Partridge, Strait of Juan de Fuca, Washington.—A first-class bell buoy in good condition.

Duwamish Head, Puget Sound, Washington.—A first-class bell buoy in good condition.

DEPOT.

Tongue Point, Columbia River, Oregon.—The keeper's dwelling, storehouses, new wharf, and grounds are in good condition. Plans were made to rebuild the old wharf where it joins, from the shore approach, the new wharf. The recommendation of last year is renewed, to erect two inexpensive oil houses (such as are used at various light-stations)

on solid ground at the end of the wharf. The danger from fire to the mineral oil stored in the wooden building on the wharf is very great and is occasioned by the cinders coming from passing river steamers which use wood for fuel.

The contractors completed the repairs of the old wharf, moving the old coal shed, building a new wharf and a new storehouse, all in accordance with the drawings and specifications. The work of repairs to the wharf was continued by hired larbor and open purchase of material for 39 feet, leaving about 201 feet of wharf approach and a new spar shed with boathouse to be rebuilt. Drawings and specifications for this work have been prepared.

TENDERS.

The Manzanita.—This steamer was laid up, for extensive repairs to her hull, machinery, and boiler, from October 3 to December 9, 1893. At other times she was constantly employed in the buoyage of the district, landing supplies, fuel, construction material, transporting mechanics, and making inspection trips. When bar and weather bound at Astoria the crew were employed at the depot repairing, cleaning, painting buoys, and the like. During the year she steamed some 10,459 miles, and consumed about 784 tons of bituminous coal. The tender made 75 inspection trips. She changed and established 137 buoys, erected, repaired, and painted 46 day marks; delivered annual supplies to the various light-stations; also 270 tons of coal, 39,300 feet of lumber, and about 500 tons of other freight.

The Columbine.—This steamer was constantly employed during the past year in the buoyage of the district, landing supplies, fuel, construction material, transporting mechanics, and making inspection trips. When bar and weather bound at Astoria the crew were employed at the buoy depot repairing, cleaning, painting buoys, and other necessary work. During the year she steamed some 14,700 miles, and burned about 1,300 tons of bituminous coal. The tender made 21 inspection trips. She changed and established 200 buoys; erected, repaired, and painted 78 day marks and light stakes; delivered annual supplies to the various light-stations; also about 150 tons of coal, 13,000 feet of lumber, and about 200 tons of other material. On May 28 she left for Alaska to attend to the buoy work in those waters. She made the trip in 24 days. She established seven new aids; changed, cleaned, and painted 53 buoys; repaired and rebuilt 26 day marks. In March, 1894, she was docked at Quartermaster Harbor, near Tacoma, Wash., and her bottom was cleaned and given three coats of antifouling paint. In June, 1894, the tender was beached near Seattle, Wash., and her injured propeller was taken off and replaced by the one she originally brought from the east.

FOURTEENTH DISTRICT.

The Fourteenth district extends, on the Ohio River, from Pittsburg, Pa., to Cairo, Ill., 966 miles; on the Tennessee River, 255½ miles; and on the Great Kanawha, 73½ miles; in all, a distance of 1,295 miles, and embraces all the aids to navigation within these limits.

Inspector.—Lieut. Commander F. W. Crocker, U. S. Navy.

Engineer.—Lieut. Col. Amos Stickney, Corps of Engineers, U. S. Army.

There are in this district—

Post lights	492
Floating lights	38
Light-keepers	483
Number of post lights discontinued	6
Number of post lights established	2
Number of floating lights discontinued	1
Number of floating lights established	4
Steamer *Goldenrod*, for supply and inspection	1

Petitions were received from masters, pilots, and business men for the establishment of new lights, and a few more can be advantageously placed. Three supply and inspection trips were made during the year, and each station was visited on each trip, except the last, when the tender was unable to go higher on the Tennessee River than Pittsburg Landing, on account of low water on Big Bend Shoals. The supplies were sent up by the courtesy of the packet line running on that river. The last trip was finished on June 25. On this trip the posts were painted, trees and brush were cleared away, and everything was left in good shape. Enough oil and supplies were left to insure the proper service of the lights through any probable continuance of low water. A sharp rise occurred in May on the upper river, but no damage was done to any of the post lights. The principal changes in post lights were made in the lower river, where the channel changes more or less every spring. The work of the light-keepers was quite satisfactory. The masters and pilots speak in complimentary terms of the service of the Light-House Establishment in this district.

TENDER.

The Goldenrod.—The steamer is in excellent condition. She steamed during the year about 7,675 miles, and consumed for all purposes some 751 tons of coal. The crew of the tender cut down 1,135 trees, cleared away 32½ acres of brush, reset 51 posts, moved 6 posts, and distributed 18,064 gallons of oil among the 530 light-stations of the district.

FIFTEENTH DISTRICT.

The Fifteenth district extends on the Mississippi River from the head of navigation to Cairo, Ill., on the Missouri River to Kansas City, Mo., and on the Illinois River from La Salle to its mouth, being in all a distance of 1,582½ miles, and embraces all the aids to navigation within these limits.

Inspector.—Commander William C. Wise, U. S. Navy, to June 1, 1894; Lieut. Commander Abraham B. H. Lillie, from June 1, 1894.

Engineer.—Lieut. Col. Charles R. Suter, Corps of Engineers, U. S. Army.

Number of lights	523
Number of keepers	332
Number of channel marks	61
Number of trees cut	814
Number of acres cleared	5¼
Number of gallons of oil used	13,044¼
Number of lights established	26
Number of lights discontinued	17
Steamer *Lily* for supply and inspection	1

During the year the efficiency of the district was well maintained, in spite of extraordinary condition of the weather, floods, and ice. Several stations were destroyed, but all have been replaced. Several outfits of oil were lost by the burning down of the keepers' houses. The number of lights was gradually increased, giving satisfaction and security to the river traffic. The number of lights on the Illinois and Missouri rivers remains substantially the same, as there is no material increase of commerce on these rivers.

The number of lights has been gradually increased on the Mississippi River, so that there are now in the district 523 lights, an increase of 9 lights. More lights are established than appear on the Light List, for during the seasons of low water numerous bad crossings are lighted; then they are discontinued when good navigable water appears; hence they are but temporary. No increase of lights on the Illinois or Missouri rivers is desirable, as it is not required by the commerce on these rivers. On the Missouri River, with 30 lights covering a distance of 180 miles, there is only one small steamer (about 400 tons burden) running, and making irregular trips.

TENDER.

The Lily.—This steamer is in good condition. The repairs made to the hull, new wheel-houses, etc., at Mound City, Ill., in December, the removal of the heavy stages and booms, the shifting of the coal bin forward, and changing her trim, rendered her more speedy and efficient. The tender made 12 trips, steaming about 6,187 miles, using some 955 tons of coal and 2 cords of wood.

SIXTEENTH DISTRICT.

The Sixteenth district extends on the Mississippi River from Cairo, Ill., to New Orleans, La., and on the Red River a distance of 8 miles, being in all a distance of 1,009 miles, and embraces all the aids to navigation within these limits.

Inspector.—Commander Andrew J. Iverson, U. S. Navy.

Engineer.—Lieut. Col. Charles R. Suter, Corps of Engineers, U. S. Army.

In this district there are—

Post lights	352
Number of keepers	331
Steamer *Joseph Henry*, for supply and inspection	1

Three hundred and fifty-two post lights are cared for by 331 keepers, an increase of 8 post lights and 7 keepers in the past twelve months. The post lights are separated by an average distance of less that 2¾ miles. The aggregate amount of the monthly pay roll of the laborers attending post lights as acting light-keepers is $3,124, an average of $8.88 per month per post light, as compared with $8.80 on June 30, 1893. The condition of the post lights and their outfits, together with the efficiency of the service rendered by the keepers, is satisfactory.

Complete inspections were made of the districts during each quarter. In December, 1893, the steam launch *Lilac* was received. Several short trips were made with it to post lights, within a radius of a hundred miles, to change the positions of lights where made necessary by shiftings of the channel.

During the year 1,404 post lights were visited, inspected, and supplied, and the keepers paid; 23 were established, 13 discontinued, and 256 moved; 81 keepers were discharged and 85 appointed. Some 1,845 trees, over 4 inches in diameter, were felled, and about 19 acres of willows, brush, etc., were cleared. Some 14,118 gallons of mineral oil were issued to keepers.

TENDER.

The Joseph Henry.—During the year a system of heating this steam tender by steam was installed, the success of which has materially lessened the expenditure of fuel. The major portion of the expense was for the covering of the auxiliary boiler and steam pipes with sectional magnesia covering. The *Joseph Henry* is now on the ways at Mound City, Ill., undergoing repairs to her hull, and it is found that the rottenness of many of her timbers and deck beams is much greater than was supposed. With the repairs now under way, she will be in tolerable condition for the next two years.

During the year the *Joseph Henry*, conveying the inspector, has

steamed some 9,195 miles, consuming some 1,019 tons of coal, and the time under steam, exclusive of 243 days' steam on the donkey boiler, was 122 days.

CONCLUSION.

In concluding this report, the Board takes pleasure in stating that each of the sixteen light-house districts into which the establishment is divided is in good working condition.

All of which is respectfully submitted.

JAS. A. GREER,
Rear-Admiral, U. S. Navy, Chairman.
GEO. F. F. WILDE,
Commander, U. S. Navy, Naval Secretary.
JOHN MILLIS,
Captain, Corps of Engineers, U. S. Army, Engineer Secretary.

The SECRETARY OF THE TREASURY.

REPORT OF THE LIGHT-HOUSE BOARD, 1894.

APPENDIX No. I.

REPORT

UPON THE

ELECTRIC BUOY PLANT IN NEW YORK LOWER BAY,

BY

LIEUT. COMMANDER CLIFFORD H. WEST, U. S. NAVY,

Assistant to the Inspector of the Third Light-House District.

ELECTRIC BUOY PLANT IN NEW YORK LOWER BAY.

OFFICE OF THE INSPECTOR OF THE THIRD LIGHT-HOUSE DISTRICT,
Tompkinsville, N. Y., August 28, 1894.

SIRS: I have the honor to transmit herewith for publication with the annual report of the Light-House Board for 1894, the report to the inspector of the Third light-house district by Lieut. Commander Clifford H. West, U. S. Navy, of the operation of the electric-buoy system near Sandy Hook, New Jersey, with a projected new system for an alternating electric current to be used in the same locality. * * *

Very respectfully,

W. S. SCHLEY,
Captain, U. S. Navy, Light-House Inspector.

The LIGHT-HOUSE BOARD,
Washington, D. C.

OFFICE OF INSPECTOR, THIRD LIGHT-HOUSE DISTRICT,
Tompkinsville, N. Y., July 1, 1894.

SIR: In obedience to your orders, I have the honor to submit the following report for the fiscal year of 1893-'94 as to the condition and efficiency of the electric-buoy plant in New York Lower Bay, off Sandy Hook, New Jersey, comprising six lighted buoys in Gedney Channel and one on Southwest Spit. Also a proposed plan for replacing the direct current installation of these Sandy Hook buoys with an installation employing an alternating current.

The Sandy Hook, New Jersey, electric-buoy installation has generally been in efficient working order during the past fiscal year. The most serious trouble that the system had to contend with was the fouling, inadvertently, of the north (red lights) cable by the dredging steamer of the U. S. Army early in January.

The submarine apparatus of the dredging steamer appears to have become entangled with the north cable at some point in the western end of Gedney Channel, where the cable passes across the channel to the north junction box. The cable was then subjected to a tremendous strain, the bad effect of which in destroying insulation apparently extended to a point very near the north end of Sandy Hook, a distance of some 14,000 feet.

The effect upon submarine cables of such undue strains is to cause them to fly into numberless kinks, and at each kink the core of the cable is generally found defective in insulation, causing bad "grounds."

For several months after the fouling of the cable by the dredging steamer the north buoy lights were a source of continuous and vexatious care. Parts of the cable were cut out at various points from the beach to the junction box and replaced by a new cable, but the insulation still continued faulty, and as a final and complete remedy the whole length of the north three-conductor circuit was replaced on May 14, 1894, by new cable. The whole system then at once returned to its normal state of efficiency, and no further trouble has been experienced since that time.

The continual and irksome care of the plant in winter time by the tenders *John Rodgers* and *Gardenia*, with the great exposure of the crews of these vessels and the employés at Sandy Hook in handling the heavy cables in winter, have led to a careful examination of electric-buoy lighting in the direction of a simpler and less cumbrous system as presented by an alternating current. Much attention has been given to this project, and the superior advantages of an alternating current as compared with a direct current in buoy lighting are set forth below in full.

During the past winter there was not sufficient floating ice in New York Lower Bay to interfere in the slightest degree with the buoy lighting. It is hardly probable that the severe experience of the very cold winter of 1892-'93, when the buoys

were inoperative for two months, due to heavy fields of floating ice, will be repeated for some years to come, as past statistics seem to show that these very cold winters occur only about once in ten years.

The buoys have now been installed about six years, and during only one season, 1892-'93, has the ice interfered with their effective display.

On August 29, 1893, during a hurricane blowing from the southwest, the *Bouquet*, the old steam launch of the *Armeria*, was totally wrecked at her moorings to the northward of the Army docks. She was nearly worn out by long service. A launch is of great use to the present direct-current installation for replacing lamps, etc., and would be of the greatest assistance with an alternating system, as a launch could readily underrun the small cable employed with an alternating current, thus rendering unnecessary the constant services of one of the depot tenders.

In November, 1893, a 25-horse-power horizontal tubular boiler was installed at the electric-buoy station in a small annex shed to the southward of the station. This boiler has proved economical, and as it is accessible in all its parts it affords great facility for its repair.

The electric cables at present in use are generally in good condition, except the single-conductor cables from the junction boxes to the buoys, which are badly worn from long use. Before increasing the stock of relief cables in store, it is important to determine whether the present system of direct current shall be maintained or whether it shall be fully supplanted by an alternating system as hereinafter set forth.

The keeper in charge of the electric-buoy station at Sandy Hook has discharged his duties efficiently during the past year.

Appended is Table I, showing the increase from year to year of the number of vessels using the Gedney Channel during the night. An account is kept by the observer at Sandy Hook of the vessels passing in and out, but probably in the darkness of the night some vessels escape his attention; so if any error is made in the reckoning, it may fairly be considered as an underestimate. By Table I it will be seen that 995 vessels passed over Gedney Bar between sunset and sunrise during the fiscal year of 1893-'94. The monthly increase of vessels of 1893-'94 over 1892-'93 was 18 per cent, while the monthly increase of vessels of 1893-'94 over 1888-'89, the year the electric buoys were installed, amounted to 159 per cent.

The month, since the electric-buoy installation, in which the greatest number of vessels passed the bar during the night—127 going in and out—was December, 1893.

From the record, there are selected at random the following cases of a few of the largest steamers plying to the port of New York, as illustrations of the facility now had in passing through Gedney Channel at night:

Date.	Name.	Line.	Hour.	Which way.
1893.				
July 29	Campania	Cunard	12:15 a.m.	Passed in.
August 4	New York	American	11:20 p.m.	Do.
September 28	Campania	Cunard	3:42 a.m.	Do.
October 7	New York	American	4:47 a.m.	Do.
October 14	Paris	do	8:10 a.m.	Do.
November 8	Lucania	Cunard	9:54 p.m.	Do.
November 18	Campania	do	5:30 a.m.	Do.

In old times, before the establishment of the electric-buoys, all the above vessels would have been compelled to have slowed down or lay outside Sandy Hook Bar, resulting in a delay in the delivery of their mails at the New York post-office of from three to eight hours.

No better demonstration of the usefulness of the electric-buoy plant could be given than the above exhibit.

Before the establishment of the present electric system Gedney Channel was buoyed farther seaward, so that the "tails of the banks" on the extreme ocean side were marked by buoys.

When the electric buoys were laid in 1888, it was not considered necessary to extend the system to the tails of these banks, and therefore the day buoys on the "tails" were also discontinued. The discontinuance of these day buoys proved an inconvenience to the pilots carrying in or out the great drafts of the present day, as with strong tides such vessels are apt to sag on to the tail of the bank on either side, especially in slowing down to discharge the pilot when proceeding to sea.

Therefore, on May 25, 1894, red nun and black can buoys were permanently established on the north and south tails of the banks at the easterly entrance to Gedney Channel, and they have proved very serviceable to the pilots.

The matter of lighting by electric buoys the north and south tails of these banks, so that the shoal water may be indicated at night, is fully treated below in connection with the proposed new alternating system for the Gedney Channel electric buoys.

The Projected System for Using an Alternating Current with the Electric Buoys off Sandy Hook, New Jersey.

The direct-current system now in use with the electric buoys in Gedney Channel necessitates the use of two large three-conductor main cables and six auxiliary single-conductor cables from the two junction boxes at the western entrance to Gedney Channel. As long as there are no faults in this complex system of subaqueous cables the buoys show good lights and are reliable as aids to navigation. At times, however, this network of cables is apt to be injured by vessels' anchors, dredging machines, etc., and then faults, "grounds," etc., rapidly accumulate. As a result, the cables require constant attention by the light-house steamers, which must come from the light-house depot at Staten Island. In midwinter the exposure of the crews of these steamers and the keepers of the dynamo station in underrunning cables to locate faults is very great, and the duty is of the most laborious and irksome nature. The expense, too, of replacing heavy cables from time to time is great. Much attention has, therefore, been given to the preparation of simpler plans for this system of buoys, which system has done such excellent work for six years past in opening the great port of New York at all hours of the night to vessels of the largest size. The alternating current seems to hold forth the greatest inducements in its introduction for simplicity of design and economy of maintenance.

THE SUBAQUEOUS CABLE.

The single-conductor copper-armored cable which it is proposed to use for the alternating system, if adopted, is shown by Fig. 1, Exhibit B. The conductor is composed of seven No. 18 (B. & S.) copper wires. The insulation is of gutta-percha, 0.325 of an inch in diameter, laid on in three separate coats. The bedding is composed of two layers of tarred jute. The armor is composed of eighteen No. 10 (B. & S.) hard drawn copper wires of a tensile strength equal to steel wire. The insulation of the cable is 400 megohms per statute mile. The diameter of this copper-armored cable, which is very pliable, is only three-fourths of an inch.

This small size of the cable makes it easy to underrun and repair. This cable could be underrun and repaired by a steam launch, instead of requiring the constant attention of the steam tenders from this depot, as is now the case, to underrun and repair the heavy three-conductor cables used in the present direct-current system.

For the Gedney Channel circuit this single cable should be landed near the Hook Beacon at the north extremity of Sandy Hook, at the place where the present cables are landed. To protect a cable of this small size from chafing on the rocks, etc., at the landing place, it should be inclosed in a piping of nonmagnetic metal, near the point of the Hook.

The cable on entering the water at the Hook should be run to the following-named buoys, in succession, as shown graphically upon Exhibit B:

	Feet.
Sandy Hook beacon to buoy B 1	10,860
Buoy B 1 to buoy G 7	2,700
Buoy G 7 to buoy G 5	2,200
Buoy G 5 to buoy G 3	2,200
Buoy G 3 to buoy G 1	2,200
Buoy G 1 to buoy G 2	1,000
Buoy G 2 to buoy G 4	2,200
Buoy G 4 to buoy G 6	2,200
Buoy G 6 to buoy G 8	2,200
Buoy G 8 to buoy B 2	3,300
Cable on buoys, 10 buoys at 100 feet	1,000
Cable slack for 10 buoys, at 60 feet	600
Total (6.18 statute miles)	32,660

SOUTHWEST SPIT CIRCUIT.

	Feet.
Distance from beach (north of Army docks) to Southwest Spit buoy (No. 12)	10,214
Cable on buoy	100
Cable slack for buoy	60
Total (1.9 statute miles)	10,374

It will be seen that by this system four more buoys will be lighted than by the present continuous-current system. Two of these buoys will be located on "the tails of the banks" at the sea entrance to Gedney Channel, about one-half a statute

mile to seaward of the present system. These lighted buoys on "the tails of the banks" are much needed, as in bringing in and taking out heavy draft vessels at night; these shoal spots are not indicated at present, and there is much danger during strong tides of heavy draft vessels being drifted on either tail of the banks. With these two electric buoys placed thus to seaward, there is an electric-lighted highway into water 40 feet deep, where heavy draft vessels are as safe as to depth of water as they would be in mid ocean. The entrance to Gedney Channel at night would also be marked so exactly that vessels could steer for it without fear of striking the tail of the bank on either side.

The present first-class nun and first-class can buoys marking the entrance to Gedney Channel would be moved in the new system slightly to seaward of the eastern electric buoys, so as to indicate the entrance by daylight in thick weather, or when, with strong ebb tides and heavy northwest gales, the electric buoys do not stand up so as to be readily seen.

In addition to these two additional electric buoys to seaward in Gedney Channel, it is also considered advisable to light, electrically, buoys B 1 and B 2 in the Bayside Channel, just to the westward of the Gedney Channel. In taking heavy draft vessels to sea their course is indicated in the Bayside Channel by the right line range of Point Comfort beacon on the Waackaack beacon, which leads the vessel to the electric buoys of Gedney Channel. But this Bayside range being a back range in going to sea, and being distant some 8 statute miles, it is not always a reliable guide in thick weather to clear the shoal spots marked by buoys B 1 and B 2. In taking out vessels of 25 feet draft and over they are liable to sag over to and ground on the shoal spots of these two buoys, as it is well known to seamen that vessels in proximity to shoal water have a tendency to head toward the shallowness, even when the helm is put hard over to keep them off. But with the buoys B 1 and B 2 electrically lighted the positions of these spots are accurately indicated, and the mariner is thus enabled to take the necessary helm precautions sufficiently in advance to make the right angle turn from the Bayside Channel into the Gedney Channel, or the opposite. Moreover, in the case of heavy vessels passing each other at night in these narrow channels, the exact width of the channel would be electrically indicated, and thus positive allowance could be made by shipmasters in running their vessels.

The alternating-current system is of such an elastic nature that the lighting of these four additional buoys in series requires only the cost of additional single-conductor cable, a trifling expense when the great advantages are considered of lighting the largely increased area of channel.

The efficiency and economy of the new system would be much increased over that of the old, as with the same expenditure of coal as at present 11 buoys would be lighted, an increase of 4 buoys over the present system. The commercial efficiency of the proposed system would be greater, as there would be a small drop of potential at the buoys in comparison with the present system, where there is an enormous loss of potential, amounting to about 50 per cent, as shown by the following recounted observations I made on May 16, 1894.

The generator having been started with a constant potential of 160 volts, and a total current of 25.5 ampères, a voltmeter was taken to each of the buoys, and the potential measured successively. The lamps used were of 100-candle power, and of about 4 ampères. During the experiments the current was shut off from the Hook Beacon light, as well as from the lamps of the keeper's dwelling. The only lamps used in addition to those of the buoys were the dynamo and station lamps.

Voltage.

[Constant potential at dynamo, 160 volts; total current, 25.5 ampères.]

Buoy G 1	77.5
Buoy G 2	86
Buoy G 3	81
Buoy G 4	83
Buoy G 5	81
Buoy G 6	82
Buoy, Southwest Spit	77

SEQUENCE OF GEDNEY CIRCUIT.

The current leaving the beach at the Hook Beacon would light buoys B 1, G 7, G 5, G 3, G 1, G 2, G 4, G 6, G 8, and B 2, in series, through the single conductor cable, and the current would return to the other pole of the dynamo by the copper armor of the cable. The total length of the Gedney circuit would be, cable 32,660 feet, plus the underground lines, 1,300 feet, making in all 33,960 feet, or 6.43 statute miles.

TRANSFORMERS.

In the head of each buoy there would be placed a transformer, so as to light the lamp by induction. In the event of a fault in any buoy it would thus not impair the general integrity of the whole lighted system. The buoy transformer cases would be filled with oil, to insure insulation between the primary and secondary coils and to exclude water. The transformer cases would be of light steel, the transformer complete not to weigh over 50 pounds. The diameter would be about 6 inches, so as to fit readily in the top of the wooden buoys now in use, which have a diameter at the head of about 9 inches.

At the dynamo station there would be a step-up transformer at each of the alternating generators, the current of 106 volts of the dynamo being transformed up to 1,060 volts for the main line of the buoys. The main transformer at the station would obviate the burning out of the dynamo from "grounds" on the line.

DYNAMOS.

Two slow-speed alternating 4-pole generators, of 9-kilo watt capacity, with a current of 40 alternations, would replace the two continuous current generators now in use. Each dynamo would generate a current of about 106 volts, transformed for the line by a step-up transformer to 1,060 volts, as previously described. One dynamo, with its engine, used at a time would be sufficient to generate current for the Gedney and Southwest Spit circuits, so the other dynamo and engine could be held in reserve for repairs.

The practice at the electric buoy station is to alternate nightly in running each group of dynamos with its attendant engine, so as to keep all machinery in full working order and under constant supervision.

Should there be serious "choking," or loss of potential due to the inductive action of the steel armor of the cable to Southwest Spit when an alternating current is used, one side of the armature of the generator might be fitted with a commutator, so as to afford a continuous current to the Southwest Spit lamp. This same current could excite the field coils of the generator, as well as light the lamps of the dynamo station and those of the keeper's dwelling.

UNDERGROUND CIRCUITS.

The direct and return wires on land from the dynamo station to the landing place at the Hook Beacon for the Gedney circuit, a distance of 1,300 feet, should be laid underground in a narrow trench, protected by creosoted wood. The same method should be used with the land wires to the Southwest Spit landing place for that cable, a distance of 600 feet. Lightning arresters for both cables should be placed in proper localities.

The overhead land wires now in use appear to be a cause of injury to the subaqueous cables, as during thunder storms, when the atmosphere is highly charged, there seems to be sufficient potential to slightly puncture the gutta-percha insulation of the cables. This perforation, imperceptible to the eye, is subsequently greatly enlarged by the lighting current, which finally causes a serious breech of the insulation, with its attendant "ground" and "burn-out."

ENGINES AND BOILERS.

The two Armington & Sims engines, at present in use, of 8-horse power, the cylinders of which are 6 by 7 inches in size, would be of sufficient power, without change, to run independently either of the two alternating generators. The 25-horse power boiler at the station would furnish sufficient power.

BUOYS, LANTERNS, LANTERN GUARDS, BUOY SINKERS, AND BUOY LAMPS.

The 50-foot juniper buoys, with their attachments of lanterns, lantern guards and sinkers, now in use, have stood the long test of six years, and are readily adaptable to the alternating system. The improved buoy lamp of 100-candle power and 5-inch globe, as introduced by Lieut. Commander West, U. S. Navy, is of the best class for the alternating system, from its nonliability to being cracked by the cold sea water of the winter months.

SANDY HOOK NORTH BEACON LIGHT.

The lamp in the lens of this beacon can be lighted by the alternating current of the Gedney Channel circuit, in the same manner as is now done, an oil lamp being provided for use in case of a temporary stoppage of the electric circuit.

METHOD OF INSTALLING BUOYS AND CABLE FOR ALTERNATING SYSTEM.

Careful sextant angles should be taken and small marking buoys be placed in the proposed positions of buoys for the alternating system, the present continuous current system remaining intact until all experiments have been completed with the alternating system.

The copper-armored single-conductor cable having been placed on board the cable steamer *Western Union*, that vessel should first land the shore end at Sandy Hook beacon. The light-house tenders *John Rodgers* and *Gardenia* should be in attendance with the ten buoys of the alternating system on their decks. The *Western Union* should lay the cable in the following sequence of buoys: B 1, G 7, G 5, G 3, G 1, G 2, G 4, G 6, G 8, and B 2. When the *Western Union* arrives at the position of each new electric buoy, indicated by the small marking buoy, 160 feet of the copper-armored cable should be bighted off, stoutly seized at the bottom of the bight, and thrown overboard. A light-house tender would then follow, and, picking up the bight of cable, fit it to its proper buoy on her deck; and when the cable is fitted to the groove, the buoy, with sinker, should be lowered overboard in its proper position, as indicated by the small marking buoy.

All the ten buoys of the new alternating system having been placed, the necessary experiments could be made in daylight for the proper working of the new system. By night, the present continuous current system could be lighted as usual. After a month's service and everything being found in good running order with the alternating system, the buoys and cable of the continuous current system could be taken up and discontinued.

The electrical plan for lighting the buoys off Sandy Hook, New Jersey, is shown by fig. 2, Exhibit B.

The installation of the brilliant bivalve electric lens at Fire Island, in conjunction with a complete alternating current system of electric buoys at Sandy Hook, and the transfer of the successful electric light-ship No. 51 to the Sandy Hook light-ship station, as well as a single telephone cable to Scotland light-vessel, will go far toward the completion of a well-devised system. These modern aids for entering the great port of New York will surpass in power, ingenuity, and enterprise anything heretofore used, giving immense assistance to the mariner and reflecting high credit upon the sagacious policy of the Light-House Board.

Very respectfully,

CLIFFORD H. WEST,
Lieutenant-Commander, U. S. Navy,
Assistant to Third Light-House Inspector.

Capt. W. S. SCHLEY, U. S. N.,
Inspector of the Third Light-House District.

Respectfully forwarded.

W. S. SCHLEY,
Captain, U. S. Navy, Inspector.

TABLE I.—*Number of vessels using Gedney Channel, New York Lower Bay, between sunset and sunrise, in the fiscal year of 1893–'94.*

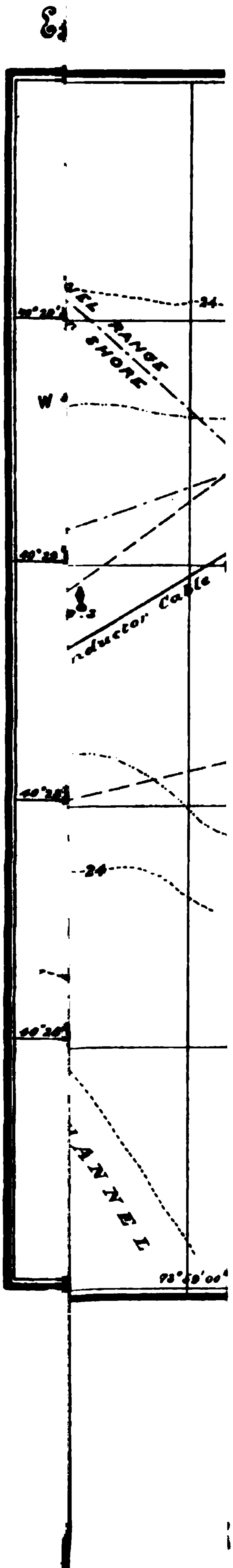
Year and month.	Bound in.	Bound out.	Total.
1893.			
July	49	31	[illegible]
August	40	19	59
September	68	29	97
October	44	23	67
November	70	34	104
December	72	55	127
1894.			
January *	46	23	[illegible]
February	48	21	[illegible]
March	69	43	112
April	59	27	86
May	44	16	60
June	39	26	65
Total	648	347	995
Average per month	54.0	28.9	82.9

* In January the north cable (red lights) was inadvertently damaged by the dredging steamer of the U. S. Army and those lights were extinguished for a time, rendering a new north cable necessary.

Synopsis showing the steady increase of vessels using Gedney Channel at night since the installation of the electric buoy plant, November 7, 1888.

Fiscal year.	Number of vessels.			Average per month.		
	Bound in.	Bound out.	Total.	Bound in.	Bound out.	Total.
1888-'89 (7 months)	171	53	224	24	8	32
1889-'90	377	192	569	31.4	16	47.4
1890-'91	470	297	767	39.1	24.7	63.8
1891-'92	533	252	785	44.4	21	65.4
1892-'93 (10 months)	487	215	702	48.7	21.5	70.2
1893-'94	648	347	995	54	28.9	82.9

Percentage of increase per month, 1893-'94 (82.9) over 1892-'93 (70.2 per cent), 18.09.
Percentage of increase per month, 1893-'94 (82.9) over 1888-'89 (32 per cent), 159.06.



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REPORT OF THE LIGHT-HOUSE BOARD, 1894.

APPENDIX No. II.

REPORT

UPON THE

FOUNDATION FOR WOLF TRAP LIGHT-HOUSE,

BY

ERIC BERGLAND,

Captain, Corps of Engineers, U. S. Army, Engineer Fifth and Sixth Light-House Districts.

FOUNDATION FOR WOLF TRAP LIGHT-HOUSE.

LIGHT-HOUSE ESTABLISHMENT,
OFFICE OF ENGINEER, FIFTH AND SIXTH DISTRICTS,
Baltimore, Md., September 11, 1894.

SIRS: I have the honor to submit the following report upon the construction of the foundation for the Wolf Trap light-station, Chesapeake Bay:

Wolf Trap Spit in Chesapeake Bay, on which the foundation for the light-station has been built, is about 12½ miles northwest of Cape Charles City, Va., 7½ miles northeast of New Point Comfort light-station, Va., and 140 miles from Baltimore, Md. The site has a depth of 15 feet of water at mean low tide; it consists, to a depth of 18 feet below the surface of the shoal, of fine sand, underlying which is a stratum of tough clay more than 10 feet in thickness, upon which the structure is founded. The tides, which here run with a maximum velocity of 1½ miles per hour, have a mean rise and fall of about 1½ feet. The site is sometimes subjected to heavy seas, and large masses of ice pass over it in severe winters.

This site had been marked since the year 1870 by an iron skeleton structure; but in spite of additional spur piles, by which the structure had been protected, it was carried away by the ice on January 22, 1893. In view of the fact that similar structures in this district had been either destroyed or damaged by the ice, or made so unsafe that the keepers had to abandon the station, it was decided to replace this important light-house by a structure erected upon a solid pier, which, by reason of its weight, should resist the destructive impact and the great pressure resulting from the moving fields of ice.

Congress, by act approved March 3, 1893, appropriated $70,000 for the construction of the new light-station, and drawings and specifications for the foundation pier were promptly prepared in the office of the Light-House Board.

The pier, upon which is erected a keeper's dwelling of brick surmounted by a fourth-order lantern, has a shell composed of 210 cast-iron plates of 1-inch, 1¼-inch, and 1½-inch thickness, held together by 1¼-inch bolts, passing through flanges, which are 6 inches wide and 1½ to 1⅝ inches thick. This shell is cylindrical, expanding to a trumpet shape at its upper end; the cylinder measures 30 feet in diameter, and the total height of the shell is 42 feet. This shell is built up in sections, seven in number, and the bottom section is bolted to the roof of a wooden caisson; it is filled with concrete to a level of 30 feet 2 inches above the roof of the caisson, and contains two water cisterns of 4,500 gallons total capacity, water conductors, and suction, overflow, and sewer pipes. The caisson has the shape of a frustum of a pyramid, its base being 32 feet 4 inches square, top 31 feet square, and height 10 feet 8 inches. It contains a working chamber which is 26 feet square and 6 feet 8 inches in height. The chamber was accessible during the sinking of the foundation by a steel air shaft 5 feet in diameter and 27 feet 5 inches in height; the upper end carries the air lock, by means of which the air shaft could be reached from without. Above the concrete level previously mentioned the pier contains a cellar divided into rooms for the storage of oil, coal, and provisions, separated from each other by brick walls, which support the house, and a number of steel beams, between which beams and the lining of the shell, brick arches have been sprung, thus making these rooms reasonably fireproof. Above the arches the dwelling is erected, leaving between the house and the upper end of the shell a gallery, which is provided with a cast-iron railing.

The materials required for and the labor performed during the construction of the pier were obtained under two different contracts; one for the furnishing and delivering at the Lazaretto Depot, Maryland, of the metal work; and the other for the construction, erection, and sinking of the pier, and filling the same with concrete up to the cellar floor. The metal work was manufactured for the sum of $6,950, and the material and work embraced in the contract for the erection of the pier was furnished and performed for the sum of $31,150. The contracts were approved by the Secretary of the Treasury in August, 1893, the delivery of the metal work was made in November, 1893, and the pier was completed in April, 1894. The work was executed

in strict accordance with the complete set of drawings and specifications furnished, and was completed without a single mishap.

The caisson was constructed of 12 by 12 inch long-leaf yellow-pine timbers, which were thoroughly bolted and driftbolted together. The joints formed by the timbers were calked with oakum and filled with hot mineral pitch to make them air-tight. The four sides and the ceiling of the working chamber were lined with 1¼-inch mill-dressed, tongued, and grooved white-pine boards, 4 inches wide, laid in white lead. The exterior vertical sides of the caisson were covered with 2-inch rough white-pine boards, and a steel cutting edge, projecting 5 inches below the woodwork of the caisson, was securely nailed to the latter. The caisson was built at the Lazaretto Depot upon launching ways placed at an inclination of 1 to 12 and having a depth of 4 feet 4 inches of water at their lower ends. Upon the runners of these ways a temporary bottom, made of 2 by 12 inch rough white-pine boards with oakum-calked joints, was constructed, and previous to launching this bottom was well stayed to the roof of the caisson by 4 by 4 inch posts placed about 4 feet apart upon 4 by 6 inch sills. The joint formed by the bottom and the caisson was well calked before the steel cutting edge was put in place, and when the second course of roof timbers and the lowest section of the air shaft were in position the structure, weighing about 95 tons, was launched and towed into deep water, where the air chamber was allowed to leak full, and the temporary bottom was drawn out beneath the cutting edge. With the bottom removed, the structure drew 8 feet ⅝ inch of water; it was made fast alongside the wharf to receive the remaining roof timbers, the two lower courses of the cast-iron shell, and the 10 by 10 inch bulkhead timbers, which, besides dividing the space above the caisson roof into three water-tight compartments, had the effect of bracing the shell and keeping it in the shape of a true circle. To increase the draft of water to 15 feet, the maximum depth allowable for reaching the site, a layer of concrete 13 inches thick was deposited in the cylinder. In this condition the floating structure had a total weight of 270 tons and a metacentric height of 3.13 feet, which proved to be amply sufficient, for on its journey to the site it behaved, as far as stability was concerned, like a well-designed vessel.

While the caisson was being prepared for towing to its destination the sand and broken stone for the concrete filling were dried in Baltimore, and the ingredients, thus freed from moisture, were thoroughly mixed a short time before they were taken to the site with Alsen's Portland cement in the proportion of 1 part of cement to 2 parts of sand and 5 parts of broken stone. The dry mixture was put into bags and loaded in the hold of a barge where it was well protected from moisture. This barge was provided with a steam derrick, with quarters for the mechanics and laborers, and carried the concrete to fill the three lower courses of the shell, the cast-iron plates of the third course of the same, the third section of the air shaft, coal, and provisions and water for the men.

In tow of a tug the caisson and barge left Baltimore on January 13, 1894. On the 19th the structure was grounded at the site by letting water into the center compartment through a 10-inch valve attached to the cast-iron shell. The two outer compartments were at once filled with concrete, the water was then pumped out of the center compartment, and this was also filled with concrete, the latter being slacked while it was being deposited in layers 3 inches in thickness.

Immediately after the caisson had been grounded, and while the cylinder was being loaded with concrete, the bottom of the bay around the caisson was protected from scour by depositing 350 tons of granite riprap stone weighing from 50 to 80 pounds each.

During the months of January and February, when storms often forced the working party to seek harbor at the mouth of the Piankatank River, the shell was filled up with concrete to the top of the air shaft, the riprap was put in place, the air lock was bolted upon the shaft, the air compressor, boilers, pumps, and coal were placed on the structure, and the fifth and sixth courses of the shell were erected. In the beginning of March everything was ready to commence sinking the structure which, by this time, had come to a good settlement, and was only about 2 feet out of plumb in 30 feet. The work under pressure, viz, sinking the pier and filling the working chamber and air shaft with concrete, lasted ten days, gangs of from 8 to 10 men each working day and night in shifts of six hours.

The air for the working chamber was furnished by a duplex compressor of the Knowles type, having steam cylinders of 12 inches diameter and 12 inches stroke, and air cylinders 14 inches in diameter and 12 inches stroke, capable of compressing 428 cubic feet of free air per minute when making 100 revolutions. During the performance of the work in the caisson the compressor was never run faster than from 60 to 80 revolutions per minute; the quantity of air furnished at this speed was found amply sufficient for keeping the air in the working chamber in a perfectly healthy state. The air did not pass through a separate cooler, but was pumped through a 4½-inch pipe provided with a check valve directly into the working chamber, whence it escaped either under the cutting edge or by the pipe through which

the sand was blown from the chamber. The concrete for filling the working chamber and air shaft was slacked before it was locked through the supply chamber of the air lock. After the air shaft had been sealed the air lock and machinery were taken off the structure, and the additional concrete, the pipes, and water cisterns were put in place, the trumpet-shaped section of the shell was erected, and the contractor, having finished the work satisfactorily, left the site on April 9, 1894.

Soundings made July 18, 1894, indicate that scour has taken place on the north, east, and west sides of the structure, the greatest depression being 6 feet. Riprap stone will be deposited as soon as practicable to prevent further erosion.

The cellar is completed and the superstructure nearly so, and it is expected that the light will be exhibited on the 20th day of September, 1894.

Respectfully, yours,

ERIC BERGLAND,
Captain of Engineers, U. S. Army,
Engineer Fifth Light-House District.

The LIGHT-HOUSE BOARD.

REPORT OF THE LIGHT-HOUSE BOARD, 1894.

APPENDIX No. III.

REPORT

BY

ARNOLD BURGES JOHNSON,

CHIEF CLERK OF THE LIGHT-HOUSE BOARD,

UPON THE EXHIBIT OF THE LIGHT-HOUSE BOARD AT THE WORLD'S COLUMBIAN EXPOSITION HELD AT CHICAGO, 1893.

LETTER OF TRANSMITTAL.

TREASURY DEPARTMENT,
OFFICE OF THE LIGHT-HOUSE BOARD,
Washington, D. C., July 10, 1894.

SIRS: Inclosed herewith I have the honor to transmit my report, made in accordance with your directions, on the exhibit of the Light-House Board at the World's Columbian Exposition, held in 1893 at Chicago.

Respectfully, yours,

A. B. JOHNSON,
Chief Clerk.

The LIGHT-HOUSE BOARD,
Washington, D. C.

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LIST OF ILLUSTRATIONS.

EXHIBIT OF THE LIGHT-HOUSE BOARD AT THE WORLD'S COLUMBIAN EXPOSITION, 1893.

I.—The Initiation.

The Secretary of the Treasury, on March 1, 1890, referred to the Light-House Board a copy of a letter from the chairman of the World's Fair Committee of the House of Representatives, dated February 26, 1890, addressed to the Department, with an indorsement asking what exhibit the Light-House Board could make at the World's Fair, and also asking information as to its nature and cost.

The matter was considered by the Light-House Board at its session on March 3, 1890, when it was—

"*Ordered*, That reply be made that double the money and space used at the World's Fair in Philadelphia in 1876, specifying both, would be needed for the exhibit of the Light-House Board at the World's Fair in Chicago in 1893."

The Light-House Board then replied on March 18, 1890, that to make a proper exhibit at the World's Fair at Chicago it would need an allotment of 5,000 square feet of wall and floor space and $15,000 in money.

Question arose as to the need of so much space and so much money, so on October 7, 1891, the Light-House Board wrote to Hon. A. B. Nettleton, Acting Secretary of the Treasury and member of the Board of Control of the World's Fair, as follows:

"Since 1876 there have been made enormous strides forward by the Light-House Establishment. Improvements of great importance have been made in illuminating apparatus, in buoys, in tenders, and light-ships, etc.

"For example, since 1876 lard oil has almost entirely disappeared and been replaced by mineral oil, and therefore the lamps have all had to be changed; bell, whistling, and gas buoys, unknown at that time, have come into common use; light-ships are beginning to have their own steam motive power, and a start has been made in the application of electricity as an illuminating agent for them, and of lenses instead of reflectors for their light.

"When it is considered that the commerce which skirts our shores, which leaves them for foreign countries, which is brought hither from other climes, which passes over the Great Lake routes from the Northwest to the East, which follows the broad rivers of the Mississippi Valley, amounts to many thousands of millions of dollars every year, and that it is all dependent for its safety on the Light-House Establishment, the Board does not hesitate to state that its services to trade are of the most important character and have a most direct and vital interest for the whole country.

"No part of the shores of this land is without its evidence of the Board's care; no channel exists which does not contain its buoys, and turn where we may by sea, there we find the forethought of the Board and its efforts to protect and care, not only for the trade of its own country, but also for the commerce of the world.

"In order to show what the Board has done in the past, to bring to view the improvements of the present, and through them to offer its earnest for the future, there are presented herewith lists of articles to be exhibited, together with photographs of many of them and two blue prints showing the arrangement of the desired space inside of the building and outside on the grounds.

"The floor space inside, which is absolutely necessary for this purpose, is a rectangle 100 feet long and 50 feet wide. The ground space outside is a square of 150 feet on a side. On the inside are to be placed all lenses, lamps, chimneys, tools, wicks, lanterns, etc.

"On the outside will be a tower, to be afterwards placed at Waackaack station, in New York Bay, buoys of various kinds, whistles, sirens, etc.

"On the walls inside will be placed a large map and large photographs and paintings illustrating some of the most important lights, beacons, light-ships, tenders, etc.

"To provide properly for all this a sum of at least $15,000 is required. Much more could be expended to advantage, but as it is understood that the funds available are limited in amount the Board has put its estimate at the lowest figure which will enable it to make a suitable display of the great institution which a generous Government has called into existence for the benefit of mankind."

This was followed by a letter from the Light-House Board to Gen. Nettleton, Acting Secretary of the Treasury and representative of the Treasury Department, dated March 24, 1892, in which was given a list of what it was proposed to exhibit, with detailed estimate of its cost.

It was found, however, that neither the space nor the funds needed could be allotted to the Light-House Board. The space was cut down to 51 by 24 feet for the exhibit inside the Government building and to 150 by 50 feet for the outside exhibit, and the funds allotted were proportionately diminished. The total amount expended from the appropriation made for the purpose, to enable the Board to make its exhibit at the Exposition, was $5,686.95.

The Light-House Board did not readily acquiesce in this reduction. On December 8, 1892, a letter was written, full of detail as to what the Light-House Board would like to do, which concluded thus:

"The Board regrets lack of opportunity of doing more, as the light-house service of every country is one of those great humanitarian institutions born of modern civilization, and the Light-House Establishment of the United States is second to none in efficiency when the great line of its seacoast, the extent of seacoast covered, and the number of its stations are considered."

The Light-House Board was thus strenuous, as it felt that its reputation, in a measure, was at stake. It had made exhibits at the World's Fair in Vienna in 1873, at the Centennial Exposition in Philadelphia in 1876, at the World's Fisheries Exhibition in London in 1883, at the Industrial Exhibition in Cincinnati in 1884, and at the World's Cotton Exhibit in New Orleans in 1884-'85, for which it received medals, diplomas, and similar evidences of appreciation. It did not now feel that it should do less at the Columbian Exposition than it had done at preceding expositions. It preferred to make no exhibit if it could not make one worthy of the Light-House Establishment and this last World's Fair.

The Light-House Board, however, was met by the board of management in a proper spirit. It was made evident by the latter body that they could not give more than they had, neither of space nor money. So it was finally agreed that the light-house exhibit, instead of being historic and exhaustive, instead of showing the growth of the service from stage to stage, instead of showing the process of its evolution, should show by the exhibition it made the point of growth to which it had arrived.

II.—The Installation.

The proper measures were thereupon taken to organize the light-house exhibit so as to show its present condition, without especial reference to its past history. The material was carefully selected, and it was put into proper shape for transportation and exhibition by the workmen employed in the shops of the general light-house depot at Tompkinsville, Staten Island, New York, or in the drafting room of the home office at Washington.

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The Light-House Board placed in charge of this work the chief of its drafting room, Mr. Jacob José, an assistant civil engineer in the Light-House Service, who, as officer in charge of previous light-house exhibits, had obtained large and varied experience. On April 24, 1893, he was ordered to Chicago. Two days after he reported in person to the proper authorities at Jackson Park, when he took charge of the reception and of the mounting of all the various articles which constituted the light-house exhibit. He remained in charge until the Exposition closed. Then he packed and shipped to its destination each article, after which he returned to Washington, where he arrived on December 26, 1893, having spent rather more than eight months on the Exposition grounds.

The delay caused by the nonreceipt, until May 27, 1893, of the first and second order lenses prevented for a time the final arrangement of the light-house exhibit, but on June 16 it was pronounced ready for inspection.

III.—The Indoor Exhibit.

The light-house exhibit in the Government building would have been confined to a space 51 by 24 feet but that the aisles were encroached upon by moving the railing on one side 3 feet 6 inches and on the other side 1 foot 9 inches. Even then the space was all too small for the articles shown.

This inside exhibit was made up of lenses, burners and their accessories, the tools used by light-house keepers, the appurtenances of light-houses, the models of light-houses and light-vessels, post lights, gas buoys, whistling buoys, etc., paintings and photographs representing typical light-houses and light-vessels, reports of and to the Light-House Board, and plans and specifications of various light-house structures.

The articles exhibited were so numerous that, taken apart, as many had to be, they reached Jackson Park packed in 4 bundles and 226 boxes.

IV.—The Illuminating Apparatus.

The illuminating apparatus exhibited consisted of only the most notable lenses and burners. The lenses shown, taking them in their order, were—

- A hyperradiant lens;
- A first-order lens, Mahan system;
- A second-order lens, Mahan system;
- A fourth-order revolving lens;
- A fifth-order lens, with occulting chimney;
- A range lens;
- Lens lanterns, with five-day reservoirs;
- Funck lanterns, with eight-day reservoirs;
- A light-vessel lantern, with lamps and reflectors;
- Lens lanterns for light vessels;
- Hand lanterns, and
- Electric-buoy lantern.

The illuminating apparatus used by the Light-House Establishment varies with the dates of its use. The beacon on Point Allerton, Massachusetts, was illumined in 1673 by "fier bales of pitch and ocum" [*sic*]. burned in open braziers. The light-house on Little Brewster Island, Boston Harbor, erected in 1715–'16, was first lighted by tallow candles. Then followed the spider lamp, burned in the lantern as it might have been in a window. In 1812 the Government bought of Mr. Winslow Lewis, for $20,000, the patent for his "magnifying and reflecting lantern." This is described as consisting of a lamp, a reflector, and what was called the magnifier. The reflector was a thin sheet of copper, commonly segments of a sphere, plated over with a slight film of silver, though the copper was so thin that its compression between the arms of its iron supports materially altered its form, and its silvered concave surface had much the grain and luster of tinware, and would reflect

no distant image. The patentee of 1812 made no pretension to a knowledge of optics as now understood, and his reflectors came about as near to a true paraboloid as did a barber's basin. The lamp, roughly constructed on the principle of Argand's fountain lamp, burning from 30 to 40 gallons of oil per year, had a three-quarter-inch burner, and was attached to a circular iron frame in front of the reflector. Before the lamp was a so-called lens, of bottle-green glass, shaped like the bull's-eye let into ship's decks, from 2½ to 4 inches thick through the axis and 9 inches in diameter, which was supposed to have some magnifying power. This apparatus was inclosed in a massive wrought-iron lantern, glazed with panes 10 by 12 inches in size. The effect of the whole was characterized by one of the reporting inspectors as making a bad light worse. But its main merit seems to have been that of economy, as the patentee, who had fitted thirty-four light-houses with his apparatus, contracted in 1816 to maintain the lights on receiving one-half the oil previously consumed, and again, in 1821, for one-third of the old allowance.

This apparatus is spoken of more respectfully in a report to the House of Representatives in 1842, made by its Committee on Commerce, from which it appears that "the improvement in the character of the light and the economy in saving oil were subjects of high commendation by the Government." It also appears that the use of the magnifying bull's-eye was gradually done away with, so that but few remained in 1838, and the last one was removed in 1840. The administration of the system was largely improved. The reflectors were made on true optical principles, approximating, if not reaching, the paraboloid in form, were heavily silvered, and were properly placed. The heavy lantern frames were replaced by lighter ones, the small panes of glass by large ones, and the ventilation of the towers was so largely improved that obscuration by smoke was no longer unpreventable. The system, largely improved, was retained, but its administration was good only where it had faithful, intelligent, and honest administrators. Finally the reflectors were so well made and so well placed that, in certain instances, it is now a question whether a better light was possible than was then furnished. Some of the old reflectors then used appear from recent examination to have had an enormous candle-power. But a poor light was the rule and a good light the exception. War was made on the system of reflectors, and when the Light-House Establishment was turned over to the Light-House Board in 1852 the reflectors were replaced by the Fresnel lenticular apparatus, found so successful in France and more or less throughout the world. Its adoption in this country made it possible for a light-keeper of average capacity to keep a good light, and impossible for him to keep a bad one, unless by violation of plain rules and avoidance of routine duties. Besides this, the saving in oil effected by use of the lenses over reflectors was so great that the expense of exchanging the one for the other was saved in a few years, although the first cost of the lenses was quite large.

THE LENS SYSTEM.

The lenticular apparatus consists of a central, powerful lamp, emitting luminous rays in every direction, around which is placed an arrangement of glass, so formed as to refract these rays into parallel beams in the required directions. When a ray of light passes out of a rarer into a denser medium, or *vice versa*, it is refracted from its original direction, and assumes that which is induced principally by the density of the second medium. This is shown in the bent appearance of an oar or a mooring where it enters the water. The glass lens appears to bend the rays which fall on and emerge from its two surfaces. The bull's-eye lantern confines its rays to one direction by the use of this principle. As the normal figure of the lens is that to which its powers are due, the polyzonal lens must be considered as a complete lens with the unnecessary portions cut away. Thus the original lens is much diminished in weight, and it also has the greater certainty of the more uniform density of the material from which it is made. It affords also the means for correcting the aberration for sphericity, a great point in the manufacture of lenses. This is the principle

of the polyzonal lens. They are applied to control the luminous rays of a lamp, by building them into a square figure for such lenses as are for revolving lights.

For a revolving light, eight of such lenses, which, for a light of the first order, have a focal length of 3 feet 0.25 inch, are formed into an octangular drum. This surrounds the central lamp, which is placed in their common focus, and it is the principal portion of the controlling apparatus.

Another adaptation of the principle is used for a fixed light. A section of the lens surrounds the focal point, and in the same plane. This produces a series of horizontal belts, with their vertical section similar to that of the lens in its circular form. This when applied to a central lamp causes a continuous belt of light in azimuth, instead of a series of beams parallel, or nearly parallel, to the axis of the circular lenses, as in the case of the revolving apparatus. In the focus of this belt, or drum of glass, the lamp is placed.

"Nothing can be more beautiful," says the great Scotch light-house engineer, Mr. Alan Stevenson, "than an entire apparatus for a fixed light of the first order. It consists of a central belt of refractors, forming a hollow cylinder 6 feet in diameter and 30 inches high; below it are six triangular rings of glass, ranged in a cylindrical form, and above a crown of thirteen rings of glass, forming by their union a hollow cage, composed of polished glass, 10 feet high and 6 feet in diameter. I know of no work of art more beautiful or creditable to the boldness, ardor, intelligence, and zeal of the artist."

In coast lights, the light is not generally required all around the horizon. Over the land in the rear there would be a waste of the light from the great lamp, which is sufficient to illuminate the whole horizon. This is avoided in the reflector light, as a small number of lamps is used. But in the dioptric apparatus the light is economized by the use of spherical mirrors placed on that side. They are generally of silvered copper curved to a radius equal to that of the focal length of the lenses to which they are applied, having the flame as a center. Thus they reflect the rays back again through the flame upon the lenses on the opposite side, and flame, being perfectly transparent, there is in this no loss of power.

THE HYPERRADIANT LENS.

This is the largest, most costly, and the farthest reaching of any illuminating apparatus in the U. S. Light-House Service. It was manufactured by Messrs. Barbier & Cie., in Paris. Its fixed white light is made by a constant level lamp, burning 7 wicks. The height of the lens is 12 feet 3¼ inches, but including its pedestal, it is 19 feet 8¼ inches high. Its diameter is 12 feet 3¼ inches, and the approximate weight of the complete apparatus is about 24,000 pounds. The intensity of the 7-wick lamp is that of about 1,080 candles. The intensity of the light through the lens is about 42,120 candles. The luminous range of the light is calculated to reach 27.09 miles; while the yearly consumption of mineral oil of the apparatus is held to be about 2,263 gallons.

The cost of the hyperradiant illuminating apparatus delivered in the United States, including the pedestal, but not lamps or other accessories, was $15,280.19. It is not yet fully decided where this magnificent lens is to be mounted. It may go to any one of the several first-class light-houses now being built. The intention of the Light-House Board is to place it where it will do the most good to commerce.

THE MAHAN SYSTEM.

Two lenses, one of the first order and one of the second order, were exhibited. The first order lens stands nearly 12 feet high and is 6 feet in diameter. The second order lens is 4 feet 7 inches in diameter, and proportionately high. They are of French make and cost from $3,000 to $5,000 each at the manufactory. They are revolving lights. The lenticular apparatus is arranged like the ordinary flash light, on one side, the other being provided with totally reflecting prisms. The Mahan system,

so called because it was devised by Capt. F. A. Mahan, Corps of Engineers, U. S. Army, then engineer secretary of the Light-House Board, consists in so arranging the obscurations that flashes of light and the intervals between them shall indicate certain numbers. The second-order lens is now on Minots Ledge light-house off Boston Harbor, Massachusetts. The number 143 is assigned to that light. That number is indicated from the lens by groups of flashes arranged thus: - ---- ---; that is to say, by three groups of flashes, the first showing one flash, the next four flashes, and the last three flashes, each group being separated by an eclipse or dark space. The flashes in a group, indicating a figure, are about 2 seconds apart. The groups are about 5 seconds apart. With the sharp brilliancy of the flash, there should be no difficulty in keeping count of the groups and of the figures in each group, and hence of the number of the light-house. As this number is being constantly repeated, with interval of 15 seconds darkness between each repetition, the mariner seeing it, on making his landfall, need only consult his light-house list to ascertain the name of the light-house bearing the number, and hence to determine his exact position. Thus he is placed beyond the possibility of mistaking one light-house for another, a mistake which has caused the wreck of many a ship.

The lens revolves once in 30 seconds. This speed is obtained by mounting the lens on a quicksilver float. Such a speed was impracticable with the old mounting on wheels or rollers. The lenses mounted in this latter way made not more than one revolution every 4 minutes, while this lens makes two revolutions each minute.

The Light-House Board has submitted the Mahan system to such thorough tentative tests that it is now at liberty to adapt it to two widely separated light-houses, one at Minots Ledge, on the Massachusetts coast, and the other at Cape Charles, on the Virginia coast.

FOURTH-ORDER REVOLVING LENS.

The fourth-order revolving lens which was shown here is described elsewhere, except that a first-order lens is figured, while the one shown was but of the fourth order. The difference is simply in size.

THE OCCULTING LIGHT. (See pp. 234, 235.)

Many harbor lights are of sufficient intensity to be seen as far as needed, but it is difficult to distinguish them from other lights. Effort was made to overcome this difficulty by obscuring the specified light automatically, from time to time, by an opaque screen. This was done by inclosing the chimney of the lamp which gives the light with a brass cylinder, which is raised to show the light and dropped to its resting place to hide it. The cylinder is raised and lowered by clockwork. The clocks are so geared that the eclipse and flashes may be as frequent as is desired, and the length of each can be regulated at will within narrow limits.

In the occulting light shown the wheel revolved once in 20 or 30 seconds, according to the positions of the fans, and each revolution caused ten flashes and ten eclipses. The machine cost about $1,000, with all its accessories.

Seven of these new occulting lights are now in use. One is shown at Tawas light-station, Michigan; one at Point Hueneme light-station, California; and others are shown at Ship John Shoal, Cross Ledge, Brandywine Shoal, Fourteen-Foot Bank, and Delaware Breakwater Front Range light-stations in Delaware Bay. Occulting lights are being constructed for certain front range lights in Delaware River.

RANGE LENS.

The range lens shown was made by Messrs. Barbier & Cie, of Paris. It was imported for use at the Waackaack light-house in New York Bay. The tower for this station was shown in the outdoor light-house exhibit. This lens is calculated to concentrate all the light given by the lamp and to project it in a given direction. The apparatus, including its mountings, is about 7 feet high. It has an interior

OCCULTING CLOCK, LENS AND LAMP

diameter of about 60 inches. It is lighted by a four-wick burner with a reflector placed behind the lamp. The beam of light projected is too bright to be borne by unprotected eyes except from a distance. Hence it was seldom lighted during the exhibition.

LANTERNS.

The lanterns shown included all the portable illuminating apparatus having an optical element, or elements of glass, whether polished or molded provided the internal diameter was less than $11\frac{13}{16}$ inches, which is the interior diameter of a sixth-order lens.

These lanterns are divided into two general classes, those of which the optical parts are made of cut glass carefully polished, and those of which the optical parts are made simply of pressed glass. The lanterns of the first class are called lens lanterns. They include important river lights and the side and anchor lights of vessels. Those of the second class are called tubular lanterns or Funck lanterns according to peculiarity of construction. In the former the air supply is introduced through tubes; in the latter the direction of the air channels is changed. The tubular and Funck lanterns are in general use as post lights on rivers where it is not necessary that they should be seen from any great distance. The tubular lantern has two serious defects, it will not burn without a chimney, and it is easily blown out by the wind. The Funck lantern was devised to remedy these defects.

Several years ago, the tubular lanterns used for post lights on rivers were modified at the general light-house depot so that they would burn eight days without attention. This modification consisted in adding a reservoir which fed the oil automatically to the lamp, on the principle of the German student lamp. These lanterns were successful in principle, but they were sometimes blown out in high winds and gave but a feeble light, as the lamp had but a small, flat wick and the lens was imperfectly made of pressed glass. The light was only equal to 18 candles.

The same principle was applied to a lantern in which cut-glass prisms were used instead of those of pressed glass. Several were made both with and without the reservoir, using the central belt of disused sixth-order lenses to concentrate the light from a Funck lamp of 32-candle power. The experiment was successful; they were not blown out by high winds, and they gave a light equal to 180 candles, more powerful than the light given by a sixth-order lens.

Without a reservoir they burn eighteen hours; with it, they burn for three days brilliantly, and they burn for two days longer with diminished intensity. They can be placed anywhere, on a post or platform; they can be exposed in any weather; they are inexpensive to maintain, and they make good substitutes for sixth or even fifth order lights. The fact that they can be depended upon to burn well for five days makes them specially valuable for localities difficult to reach in stormy weather. More than 100 are now in use, and the number is increasing yearly. In addition, they make excellent running lights for steamers. They are colored red or green for use as port or starboard lights, by the use of red or green glass globes. They cost about $125 each. A full description of them, under their official name of lens lanterns is given on page 260 in the Annual Report of the Light-House Board for 1892.

Among the lens lanterns shown were:

A Funck lantern, red,
A Funck lantern with an 8-day reservoir,
A lens lantern with a 5-day reservoir,
Three lens lanterns for light-vessels, and
A hand lantern.

TUBULAR LANTERNS AND POST LANTERNS.

As the tubular lanterns were liable to be extinguished in high winds, the Light-House Board directed that experiments be made with tubeless lanterns in order to overcome that difficulty. A lantern was devised which has given excellent results.

It has no chimney; it is simply and strongly made of brass, and it costs less than the tubular lanterns. It can be arranged with a reservoir so as to burn fully eight days. The new lantern is called a Funck lantern. It is named from the foreman of the Light-House Board lamp shop, Mr. Funck, who devised and perfected it.

The brass white tubular lanterns cost $15.50, and the red one costs $18 each. The brass tubeless or Funck lanterns, often called post lanterns, cost, the white ones $13, and the red ones $15.50 each. The brass post lanterns with reservoir cost, the white ones $21.35, and the red ones $23.85 each.

LIGHT-VESSEL LANTERN WITH REFLECTORS AND LAMPS.

A light-vessel lantern with reflectors and lamps was also exhibited. A light-ship shows a light on one or both of its masts. The light may be fixed or flashing. The fixed light is formed of 8 mineral-oil lamps attached to a ring which encircles the mast. Behind each lamp is a parabolic reflector, 12 inches in diameter, which concentrates into a single beam all the light which would be lost were it not used. The lamps and reflectors are inclosed in a glass lantern which protects them from the wind and weather. The whole apparatus is hoisted to the head of the mast at night. It is housed by day in a shelter at the foot of the mast.

A flashing light is sometimes obtained by causing a series of opaque screens to travel around the lamps just inside the lantern. The screens cause the light to be shown and obscured alternately. The light-vessel off Cornfield Point in Long Island Sound shows an electric flashing light. On each of its masts are placed four 100-candle-power incandescent electric lamps, each inside of a lens lantern. By alternately turning the current off and on, the lamps are extinguished or lighted, thus producing the effect of a flashing light.

LIGHT-SHIP LANTERN.

The light-ship lantern exhibited which had been built in the shops at the general light-house depot, is 4 feet 10 inches high, 5 feet 5½ inches in diameter, and is eight sided. It weighs complete for use, with its lamps and appurtenances, about a ton. Being built in halves, it can be fitted conveniently around the 16-inch mast on which it is to be hoisted. The lantern was made from detailed plans and specifications which can be found on pages 23-32 of the quarto publication of the Light-House Board, entitled "Specifications for light-vessels Nos. 51, 52, 53, 54," printed in 1891. This monograph was also on exhibition.

LENS LANTERNS FOR LIGHT-SHIPS.

Several small light-ships were built for service on the upper lakes. They can not carry safely at their mastheads the heavy lanterns described above. It was therefore decided to use instead the newly invented lens lanterns. Three of these lanterns, hung on gimbals supported by brackets, are placed on each mast. The brackets are fastened to a ring which surrounds the mast. The lens lanterns thus used give entire satisfaction.

A set of three lens lanterns, with brackets, gimbals, lamps, etc., complete, weighs about 700 pounds and costs about $620, while the ordinary light-ship lantern with all its appurtenances ready for hoisting costs about $1,100 and weighs about 3,000 pounds. The lens lanterns were set up and shown on a section of a mast, from the opening of the Exposition until August 30, 1893, when they were taken down and sent to the light-ship for which they were made. This ship is now stationed off Bar Point in Lake Erie, near the mouth of the Detroit River.

V.—KEEPERS' LIBRARIES.

A library such as is furnished to light-stations was shown. It is made about 2 feet high, 2 feet wide, and 8 inches deep, of shellacked white pine and is strengthened with heavy brass trimmings. It has two shelves of different heights. Its two

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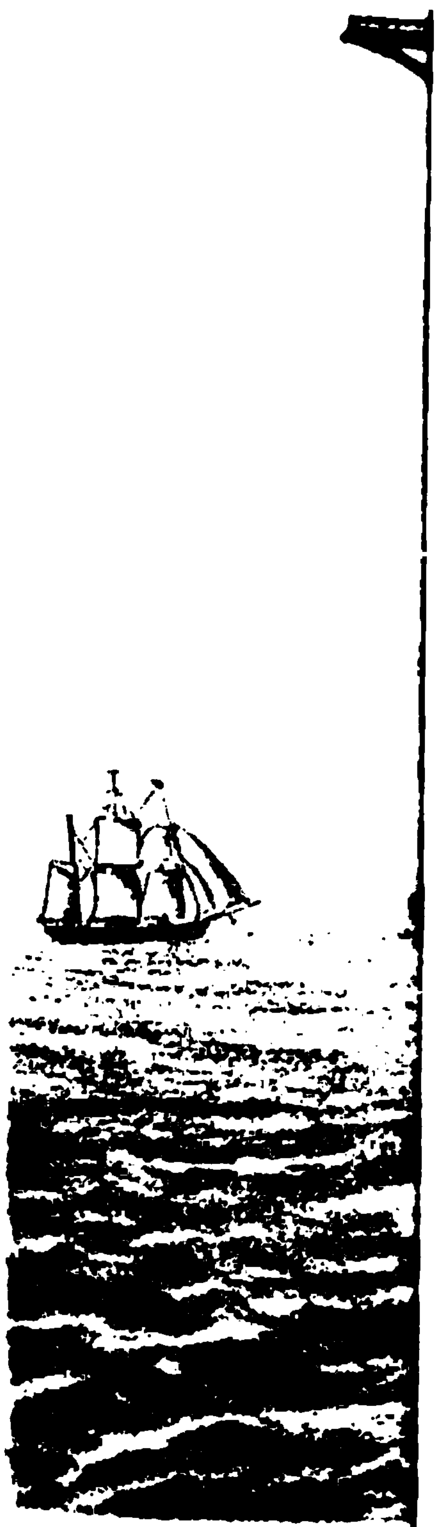

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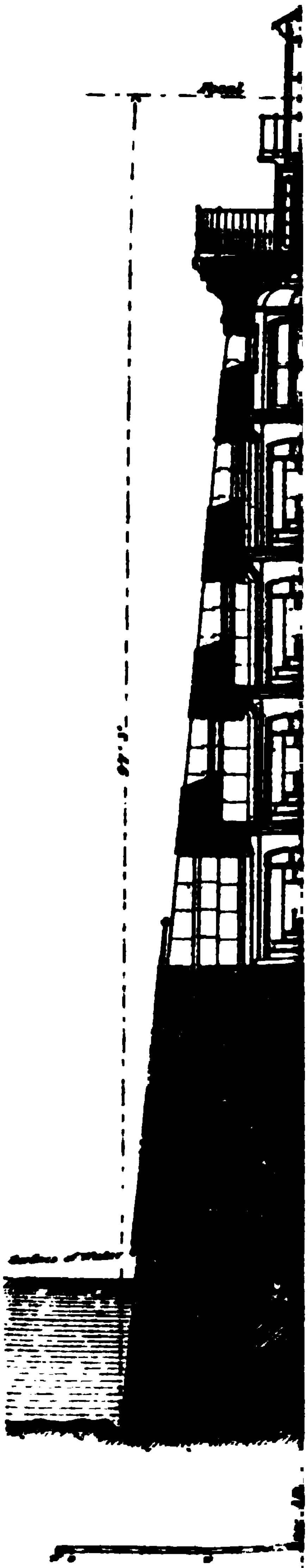

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doors are secured, the one with an inside bolt and the other with a mortised lock. On the sides are hinged handles. When locked, the library cases can stand rough handling.

These libraries were originated by the necessity for doing something to satisfy the intellectual requirement of the light-keepers and their families. The cases of these libraries are so constructed that they make rather a neat appearance when set upright on a table; when closed and locked, they are ready for transportation. Each contains on an average about 40 volumes of a proper admixture of historic, scientific, and poetic matter, with some good novels. A library is left at a station for some three months, when it is exchanged and passed on to another station. This is usually done when the light-house inspector makes his quarterly inspection. Each station to which a library is furnished sees, in this way, some 150 different books each year. There are now about 700 of these libraries in circulation, and more are in preparation. Preference is given in their distribution to those light-stations most distant from towns and villages.

VI.—Miscellaneous.

Samples of lamp chimneys and lamp wicks were shown, as were also samples of the implements, including the various brushes used in keeping the lamps and lenses in order. A tool chest fitted with the tools needed for the service of a light-station, a pendulum clock, a set of the holland curtains hung in the lantern during the day to protect the lens, and a set of the pennants and ensigns used in the Light-House Service were exhibited.

VII.—Specifications.

There were also shown fourteen bound volumes of drawings and specifications of light-houses, light-keepers' dwellings, light-ships, light-house steam or sailing tenders, day beacons, and buoys. The plans of the light-house steamers and the light-ships measure 30 by 24 inches. The plans of the light-houses are 14 inches one way and 16 the other. The specifications are published in quarto, which are 9 inches broad and 12 inches long. The plans and specifications were those furnished to contractors, from which they were required to perform their contracts. They were prepared, as a rule, in the home office of the Light-House Board and were printed at the Government Printing Office in Washington. They are so full and precise that contractors seldom need other instructions than those contained in the plans and specifications as explained to them by the superintendent of construction in charge of the work, who inspects both material and labor.

It is the practice of the Light-House Board to prescribe everything in advance, to inspect all material that enters into the structure, and to accept nothing that does not come up to its prescribed requirements. It has in its employ a corps of experts who are constantly at its orders. When material is ready for inspection, the Light-House Board is notified, and it sends that expert to do the work who is at the moment nearest to where the material is lying, and who can be spared best from other work. It usually happens that the contractor does not know who will inspect his work, and the inspector does not know what work he will next inspect. Hence it becomes practically impossible for the manufacturer and the inspecting officer to come to any permanent understanding, or one which may not be discovered and upset at the next inspection, which is quite likely to be made by another expert.

Take the case of an iron light-ship recently under construction. A firm which took the contract for the ship at a lump sum made subcontracts for the plates, the frames, the rivets, the boilers, the engines, the stem, the stern post, the keel, etc., with 13 different firms in 13 different places. As time was an element in the contract and there was a heavy penalty for each day's delay, the subcontractors, though distant from each other, were turning out their material quite near together in point of time, and sometimes simultaneously. Hence the different inspecting officers examined different parts of the work, at different places, but at the same

time. Each piece of metal, be it a plate, rivet rod, a heavy forging, or what not, was inspected as to surface indications, as to its tensile strength, and indeed as to its component parts, before it left the works where it was made. If it passed inspection it was branded with the stamp of the Light-House Board. If it was condemned—and much was condemned—it was rejected. The superintendent of construction at the shipyard allowed no piece of metal to enter into the construction of the ship that was not stamped, and until it had passed his own inspection as to weight, size, and the like. He was expected to see and pass upon every part of the work done. Then, from time to time, the superintending engineer of the service visited the work, inspected the inspector, and examined the work in sight. Under this rigid system of accountability the Light-House Board has obtained good work at low prices. But some contractors, who could not be made to believe in advance that they would or could be held to the requirements in the plans and specifications, are now beseeching Congress for relief, and are trying to prove, and in some instances are showing, that they have not been properly paid for their material and labor, although they received promptly all payments called for by their contracts.

The plans and specifications shown are not enumerated, as to do so simply would be to make a catalogue of works of which many have already been mentioned.

VIII.—Light-House Board Annual Reports.

The Light-House Board was organized in 1852, and took over from the Fifth Auditor of the Treasury Department, then its superintendent, the charge of the Light-House Establishment. The Board has, from its organization, made a yearly report to the Secretary of the Treasury. Until 1867 the report was printed in the finance report. After that date it was represented by a page in the annual report of the Secretary of the Treasury; but the report for 1867 appeared at length in a separate publication of 46 octavo pages. For some years it had paper covers. For a few years more it appeared in flexible covers, but it was not until 1872 that it attained the dignity of a bound volume. The size of the report increased with the growth of the Light-House Establishment. In 1859 it filled 12 pages, but for the past several years it has had an average bulk of 250 pages, with copious illustrations. These reports chronicle the growth of the Light-House Establishment.

It appears from Report No. 811 of the Twenty-seventh Congress, second session, dated May 25, 1842, that in the year 1791 the United States had but 10 light-houses, and they were maintained at a cost of about $22,000 per year. From that period to the present the increase has hardly kept pace with the rapidly-growing commerce of the country.

In 1820 the number of light-houses was 55. The whole expenditure for that year was $244,000.

In 1835 the number of light-houses was 201. The expenditure for them was $382,000.

In 1841 the number of light-houses was 256; light-vessels, 30; day beacons, 35; buoys, about 1,000. The entire expense of 1841 was $474,000.

The total cost of the light-house, light-boat, beacon, and buoy establishment, including cost of sites, buildings, repairs, maintenance, etc., was from 1791 to 1817 in round numbers $1,872,000; from 1817 to 1841, $7,216,000; total, $9,088,000, being an average yearly expense of about $180,000.

The total cost of building light-houses, including cost of sites, light-boats, beacons and buoys from 1791 to 1817 was $305,000; from 1817 to 1841, $1,910,000; total, $2,215,000. Deduct cost of beacons and buoys, $500,000; total for 286 light-houses and boats, $1,715,000; being an average of about $6,000, showing, as the committee whose report is quoted says, great economy in these constructions.

From the same report it appears that the Fifth Auditor of the Treasury, acting as superintendent of the Light-House Establishment, reported that the construction of the 33 light-boats in service in 1842 cost about $9,100 each.

Ohio River Post-light and the Light-house Steam Tender Lily.

FIRST-CLASS LIGHT-VESSEL WITH STEAM FOG-SIGNAL.

In 1842 there were nearly 1,000 buoys; in 1852 there were 1,012, and in 1858 there were 1,034.

The annual report for 1853 shows that on July 1, 1852, there were under the charge of the Light-House Establishment—

Light-houses	347
Light-ships	44
Beacons, about	168

The expenditure for the maintenance of the Light-House Establishment for the fiscal year ending June 30, 1853, was $816,792.32. The estimate for the next year was $890,033.42.

The annual report for 1893 shows that forty years after, on July 1, 1893, there were under the charge of the Light-House Establishment—

Light-houses and beacon lights, including the 361 post lights in the Third, Fourth, Fifth, Sixth, Eighth, Twelfth and Thirteenth light-house districts.	1,312
Light-ships in position	33
Light-ships for relief	6
Electric buoys in position	20
Gas buoys in position	2
Fog signals operated by steam or hot air	114
Fog signals operated by clockwork	189
Post lights on the Western rivers	1,389
Post lights on other rivers	361
Day or unlighted beacons	419
Whistling buoys in position	64
Bell buoys in position	90
Other buoys in position, including pile buoys and stakes in Fifth district and buoys in Alaskan waters	4,315

In the construction, care, and maintenance of these aids to navigation there were employed—

Steam tenders	30
Steam launches	8
Sailing tenders	2
Light-keepers	1,139
Other employés, including crews of light-ships and tenders	821
Laborers in charge of Western river lights	1,135
Laborers in charge of other river post lights	368
The amount expended for the maintenance of the Light-House Establishment during the fiscal year ending June 30, 1893, was about	$2,558,500
The estimate of the amount needed to maintain the Light-House Establishment for the next year is	3,076,000

Many of the professional papers written by its officers and published by the Light-House Board have appeared in the appendices to its annual reports. Several of the most important papers on the laws of sound, by Prof. Joseph Henry, who was a member of the Light-House Board as well as Secretary of the Smithsonian Institution, several of the papers on applied electricity by Dr. Henry Morton, president of the Stevens Institute of Technology, appeared thus, they being his reports to the Light-House Board as chairman of its committee on experiments. The papers of Lieut. John Millis, Corps of Engineers, U. S. Army, on the adaptation of electricity to use as a light-house illuminant were thus published as he was, when he wrote them, assistant to the engineer of the Third light-house district. The report made in 1887 by Lieut. Commander F. E. Chadwick, U. S. Navy, then naval attaché to the U. S. legation at the court of St. James, of the elaborate and long-continued experiments made by the British light-house service—the Trinity House—at the South Foreland with various light-house apparatus, and with all the various light-house

illuminants, oil, gas, electricity, etc., was made to the Light-House Board, as he was connected with the light-house service when he was sent abroad, and this valuable paper appeared as an appendix to the annual report of the Light-House Board for 1885. Scarcely an annual report has appeared that does not contain a professional paper which belongs to permanent scientific literature. This may account for the fact that the issue of 2,600 copies is, after the wants of mariners are met, soon exhausted in supplying the demands of public, collegiate, and purely scientific libraries.

IX.—The Models.

There were three models of typical light-houses exhibited. They were those of:

MINOTS LEDGE LIGHT-HOUSE. (See frontispiece.)

Minots Ledge light-house, off Boston harbor, Mass., is one of the most important engineering works of the Light-House Establishment. It ranks, by the difficulties which attended its erection and by the skill and science shown in the details of its construction, among the chief of the great sea-rock light-houses of the world. A careful survey of the rock having been made, the preparation of the plan of the masonry tower for this difficult position was devolved on the then chairman of the Light-House Board's committee on engineering, Col. Totten, Chief of Engineers, U. S. Army. This was done so successfully that, with slight exception, the tower was built throughout according to the plans of Gen. Totten by Lieut. B. S. Alexander, Corps of Engineers, who had charge of the entire construction of the tower.

The last stone was laid June 29, 1860, five years after the beginning of the work on the ledge. The cost of the entire work, including the keepers' houses on shore, was about $300,000. The tower, which is 89 feet high, is built of granite. As it stands in the water among rocks, it is only accessible by small boats and in good weather.

The model shown is 8 feet high. It is built of wood so painted as to show how each stone used in the construction of the tower is doweled into its mates laterally as well as above and below. The model is built on a scale of 1 inch to the foot.

A quarter of the exterior portion of the tower is cut out and hinged, so that it can be opened and its interior arrangement seen.

An oil painting, measuring some 2 feet by 3 feet, was also shown, representing Minots Ledge light-house during a storm. The waves appear to be striking against the tower and the spray is shown as flying high up towards the lantern itself.

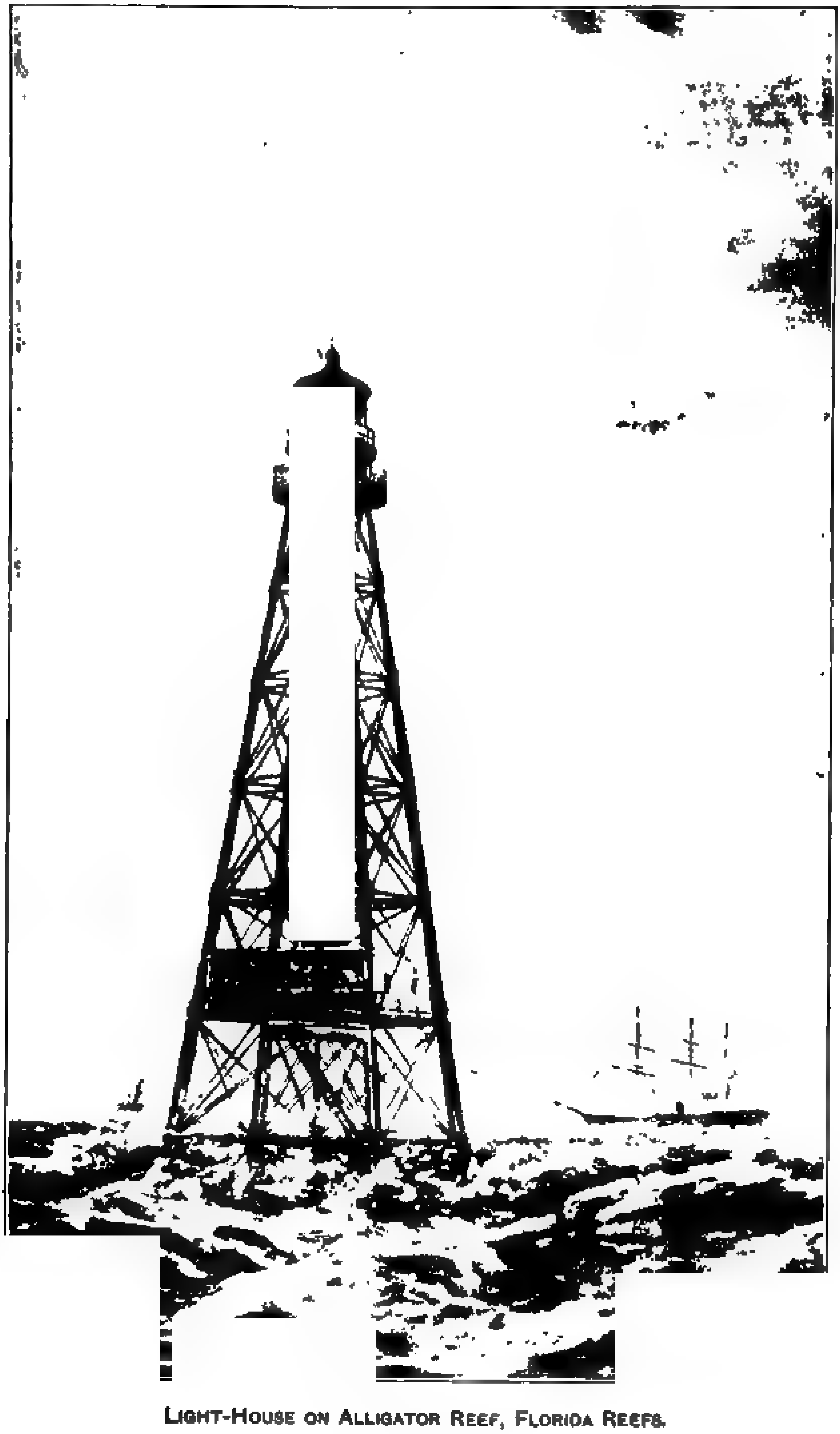
The light formerly at Minots Ledge has been replaced since the close of the Exposition by the flashing Mahan light, which was shown at the Exposition. It repeats its number, 143, continuously by a series of groups of flashes separated by partial eclipses, as is described on another page, under the head of The Mahan system.

The light consumes about 875 gallons of mineral oil each year. The station is attended by four keepers. The pay of the principal keeper is $1,000 per year, and this is the only case in which the pay of a specified light-keeper is fixed by law. The other three keepers each receive $550 per year.

FOWEY ROCKS LIGHT-HOUSE FLORIDA. (See p. 236.)

This structure was commenced in 1875 and finished in 1878. It stands on the extreme northern point of the Florida reefs. The height of the tower from the surface of the water to the focal plane of the light is 110½ feet. It is a dark brown pyramidal frame work of iron, which rests on wrought iron piles driven about 10 feet into the live coral rock. The iron framework incloses an iron dwelling for the keepers. This is connected with the iron lantern by a stairway built inside of the iron cylinder.

The model shown was made, not for exhibition, but to serve as a guide in planning future structures of like kind. It is made of many separate parts, and is planned accurately to a scale of three-fourths of an inch to the foot. The material is brass



LIGHT-HOUSE ON ALLIGATOR REEF, FLORIDA REEFS.

Fourth Order Light-House on South West Ledge, Long Island Sound.

silver-plated and oxidized so as to resemble iron. That part which shows the light-keeper's dwelling is also carefully constructed. The model attracted much attention, not only on account of its intrinsic merits, but because of its beauty and novelty.

A water-color picture of this light-house was also shown. In it the tower is indicated as standing in lonely grandeur with the waves gently lapping its base, in the clear bright light of the subtropical day, with nothing in sight except a few vessels at varying distances, which aid in giving an idea of its height.

It cost about $163,015 to build this structure. It consumes yearly about 2,225 gallons of mineral oil; and it is cared for by three keepers, who receive each year $820, $510, and $490, respectively, for their services.

SPECTACLE REEF LIGHT-HOUSE, LAKE HURON, MICHIGAN. (See p. 237.)

This is a structure similar to that on Minots Ledge. It stands on a limestone reef at the northern end of Lake Huron. The nearest land is 10¼ miles distant, but it is 16 miles from Scammons Harbor, where the stone, etc., for it was prepared. Although the waves which reach the tower have a fetch of 170 miles from the southeast, they can have but little effect on the structure, owing to the shallowness of the water in which it stands. The tower had to be built to withstand the effects of ice which, moving in solid fields of thousands of acres in area and of 2 feet or more in thickness, and under the influence of currents of several miles an hour, exerts an almost irresistible force. The first action of the resistance of the pier of protection is to crush the ice and to cause it to pile up around the structure. The piled-up mass then grounds on the shoal and prevents the further advance of the drifting field. The depth of the water where the tower stands is but 7 feet. The tower is in shape the frustum of a cone, 32 feet in diameter at the base and 18 feet at the spring of the cornice, 80 feet above the base. The entire height of the masonry above the base is 93 feet, and of the focal plane 97 feet 3 inches. For the first 34 feet the tower is solid; from thence it is hollow. There are 5 rooms in it, one above the other, each 14 feet in diameter, with heights varying from 9 feet 2 inches to 7 feet 8 inches. The walls of the hollow portion are 5 feet 6 inches at the bottom, and they taper to 18 inches at the spring of the cornice. The interior is lined with a 4-inch brick wall, between which and the outer stone masonry is a 2-inch air space.

The blocks of stone below the cornice are all 2 feet thick. Those of the solid portion of the tower were cut to form a lock on each other in each course, and the courses are fastened together with wrought-iron bolts. Each bolt is wedged at both ends, and the bolt holes are plugged with Portland cement, which is now as hard as the stone itself. The stones were cut, as were those of Minots Ledge light-house, at the depot on shore, and were fitted, course by course, on a platform of masonry.

The main difficulty, however, lay, as at Minots Ledge tower, in the preparation of the foundation. This was overcome by a pier of protection inclosing a cofferdam. The pier was a crib work of 12-inch timbers built upon ways and launched at the depot at Scammons Harbor. The crib was towed some 16 miles by a number of steamers to the reef, where it was grounded on its site. It was of wood, 92 feet square outside and 24 feet high. An open space 48 feet square was left in the center. The crib was divided into compartments, which were ballasted to make it firm. Thus were formed a protected pond for the cofferdam, a landing wharf for material, and a secure platform for the quarters of the men, all 12 feet above water, and out of reach of ordinary waves.

The cofferdam was a circular cylinder 36 feet in diameter. It was made of jointed staves 14 feet long, 4 inches thick, and 6 inches wide, held in place like those of a tub, by three iron hoops, and braced and stayed inside against a center post, the axis of which coincided with the axis of the cylinder. It was built at the surface of the water, and suspended exactly over the site of the tower. A loosely twisted inch-and-a-half rope of oakum was tacked to the lower end of the staves and then the

cylinder was lowered to the bottom. The bed rock was quite irregular on its surface, the irregularities within the cylinder amounting to as much as 3 feet in vertical height. But with a heavy top maul each stave was driven down, retaining between its lower end and the rock a corresponding portion of the oakum rope which thus served as calking. The cylinder was made approximately water-tight by an ingenious arrangement of a loosely twisted 4-inch hay rope and a canvas flap, which was attached in part to the outside of the lower edge of the cylinder and which lay in part flat on the rock, and which was forced into the angle by the outside pressure when the pumps commenced lowering the water in the dam.

The work was commenced in May, 1870, and the light was first exhibited from the finished structure in June, 1874; but the available working time spent on this light-house was but about twenty months. This tower cost, including the steamer and appliances of all kinds, about $375,000. It was planned and built by Gen. O. M. Poe, colonel of engineers, U. S. Army, he who was Gen. Sherman's chief engineer in his march to the sea. Its strength has been thoroughly tested already by many ice pushes. The light is only shown during the season of navigation. When the keepers returned to the tower on May 15, 1874, they found the ice piled against it to a height of 30 feet, which is 7 feet higher than the doorway. They could not effect an entrance to the tower until they had cut through this mass of ice.

The model of this light-house is made of wood and is 3 feet 6 inches high. It shows the crib, the cofferdam, and the tower.

There is consumed yearly in producing the light about 429 gallons of mineral oil. The four keepers employed here during the season of navigation, which usually lasts from about the middle of March to near the middle of December, are paid, the principal keeper at the rate of $800, and the other three at the rate of $500, $475, and $450, respectively, per year.

The fog signal used at Spectacle Reef light-house is a 10-inch steam whistle. It was in operation during the fiscal year which ended June 30, 1893, for 154 hours, in which time it burned 8 tons of coal.

X.—The Western River Lights. (See p. 238.)

The commerce of the Western rivers was largely restricted to movement by daylight, because of the difficulty in keeping steamboats in the tortuous channels and in avoiding the obstructions with which the channels abound. There were in 1873-'74 on the Mississippi, Missouri, and Ohio rivers, 1,932 steamers and other licensed craft, which, with the unlicensed craft, measured about 1,200,000 tons and carried cargoes amounting in value to about $400,000,000 per year. The navigation of these waters is of the most intricate character. At many points passage was never attempted on a dark night. The hidden obstructions are numberless, and in many places barely leave room for the passage of a large steamer. There are many consecutive miles on these rivers where the wrecks average more than one to the mile.

Congress has provided since 1874 for lighting these rivers. The light used is shown from a substantially made lantern, supported by a post at an elevation of from 8 to 10 feet from the ground. From the testimonials of steamboat lines, boards of trade, and others interested in the navigation of those waters, these lights appear to be a great benefit to river commerce.

The river lights are separate and distinct from other lights. They are doing an immense deal of good, meeting a popular want economically, quickly, and well, and are admirably serving their purpose.

The light is placed in pressed-glass lens lanterns, described in a foregoing paragraph as post lights. They are kept at a cost not exceeding $10 per month each.

During the year 1893 the Light-House Board maintained on 27 rivers about 1,750 of these lights, at an expense of $300,000 for the year

The models of the Western river post light exhibit are made on a scale of 1 inch to the foot.

Thimble Light-house, Hampton Roads, Virginia.

XI.—The Gas Buoy.

The gas buoy was represented by a model made of brass and painted to resemble the actual buoy. It was 15 inches high and was fitted with a lantern, a chain, and a ballast ball. It simulated the pear-shaped buoy, hence it had no tube or tail. A full-sized gas buoy was placed in the outdoor exhibit and will be described in its order.

XII.—The Whistling Buoy.

This buoy was also indicated here by a model made of nickel-plated brass. It was 3 feet 6 inches high and was of the Courtenay variety. A full-sized whistling buoy which had been in use was shown in the outdoor exhibit. An account of it will appear in its proper place.

XIII.—Light-Ships. (See p. 239.)

The light-ship No. 40, a model of which was shown, was built at Wilmington, Del., in 1875, at a cost of $39,200 for the hull alone. The ship is of white oak and is copper fastened. It is about 115 feet long, 27 feet beam, and her draft when loaded is about 13 feet. She carries two lanterns with 8 reflector lamps in each. The illuminant used is mineral oil. The lanterns are of the kind described in a foregoing paragraph under the head of light-ship lanterns. The fog signals are a 12-inch steam whistle and a 1,000-pound bell. The light-ship is of about 350 tons measurement.

The model was made on the scale of three-fourths of an inch to the foot. It gives an excellent idea of the vessel full rigged and ready for service. A builder's model, showing its lines, was also exhibited.

There are now some 44 light-ships in the Light-House Service. Three are on the rivers, 7 on the lakes, 2 in the Gulf of Mexico, 1 in the Pacific Ocean, and 31 in the Atlantic Ocean. The river light-ships are small, temporary, cheap affairs, costing about $1,000 each to build and about $100 per month to maintain. The lake light-ships are larger, but they are only intended to serve until they can be replaced by light-houses. They cost from $15,000 to $25,000 each to build, and they are maintained at a cost of from $150 to $350 per month during the season of navigation, say for eight to nine months in the year. They are laid up during the winter. The difference in the cost of maintenance is occasioned by the fact that some carry steam fog signals, some have also steam motive power, and some have neither the one nor the other.

Of the vessels on the Atlantic coast the older and smaller wooden ships are stationed in the bays, sounds, gulfs, and similar sheltered waters. They cost, according to their size and age, from $30,000 to $50,000 to build and from $4,000 to $5,000 per year to maintain.

The best light-ships yet built by the Light-House Board are for exposed outside ocean stations. They are of steel, about 119 feet long, 26½ feet broad, 14½ feet deep, have steam motive power sufficient to get to and from their stations and to steam up to their moorings in very heavy weather, and have steam fog signals. One of them, that at Sandy Hook, New York Bay, shows the only revolving lens light on a light-ship in United States waters. Another, that at Cornfield Point, Long Island Sound, shows the only electric light on a light-ship anywhere in the world. These last-named light-ships cost about $70,000 to build and equip and about $9,000 a year to maintain. The Cornfield Point electric-lighted light-ship cost for maintenance last year $10,997.91, owing to its inordinate consumption of coal. This, however, was experimental, and the cost will be largely reduced another year.

Light-ship No. 40, the model of which was shown, was stationed last year at Five-Fathom Bank, off Cape May, New Jersey. The crew consists of 4 officers and 6 men. Its maintenance cost $5,867.02 during the last fiscal year.

There was burned in keeping up the lights of this ship during the fiscal year which ended June 30, 1893, 1,138 gallons of mineral oil. The fog signal she used is

a 12-inch steam whistle, which was in operation during that time 451 hours, in doing which 22 tons of coal were consumed.

XIV.—Oil Paintings.

One oil painting represented Minots Ledge light-house, Massachusetts, in a storm. This light-house is described on another page.

ALLIGATOR REEF LIGHT-HOUSE, FLORIDA. (See p. 240.)

The other oil painting represented this structure, which is a pyramidal iron framework 135½ feet high, standing on the Florida reef in 5 feet of water, within a quarter of a mile of the deep waters of the Gulf of Mexico. The iron framework incloses a keeper's dwelling. It is connected by a circular staircase with the lantern which carries a first-order flashing light, visible 20¾ miles. This is one of the finest and most effective lights on the coast. Its flashes are red and white. The red flash is thrown through sectors so arranged that the red light falls upon dangerous water, while the white indicates to the mariner the way of safety. The principal lights on the Florida reefs have been recently fitted with these red sectors, by which their usefulness is greatly increased.

Alligator Reef light-house cost about $185,000. It requires 2,206 gallons of oil per year to feed the light, and it is in charge of three keepers. The principal keeper is paid $820 a year; the first and second assistant keepers are paid $510 and $490, respectively.

XV.—Water Colors.

There were ten water colors of typical light-houses shown. They were of—

SOUTHWEST LEDGE LIGHT-HOUSE. (See pp. 241, 242.)

This is a fine specimen of the structures built on a tubular foundation. It is erected on a rock in Long Island Sound, at the mouth of the harbor of New Haven, Conn., about a mile from the land. The surface of the ledge is made to approximate a level by a layer of concrete at least 4 feet thick. Two courses of masonry, each 18 inches thick, are laid on the concrete. The upper surface of the masonry is 4 feet below mean low water, 10 feet below mean high water, and 11 feet 3 inches below extreme high water. The foundation of the cylinder rests directly on the masonry. It is composed of cast-iron plates 6 feet high, 4 feet wide, and 2 inches thick, with a curve of 15°, bolted together. This cylinder is 24 feet in diameter and about 30 feet high. The top of its gallery is a fraction over 18 feet above extreme high tide.

It is filled in solidly with concrete to the top. An enrockment of about 3,000 tons of large granite blocks surrounds the pier. The tubular foundation is surmounted by an octagonally shaped house and tower. Its fourth-order fixed white light is 57 feet above the level of the sea and is visible 15 miles. It was first lighted on January 1, 1878. The peculiarity of the structure is that, being round, it offers slight obstruction to floating ice, and that above the foundation it is a monolith of artificial stone, surrounded by a veneering of iron sufficient to retain it in place until the concrete filling gained the requisite hardness by age. This was the first of a number of structures of the same kind, and its stability has been thoroughly tested.

This station cost $100,000 to establish. Its annual consumption of mineral oil is 231 gallons, and it employs one keeper, who receives $640 per year.

The fog signal at this station was a second-class Daboll trumpet. As it failed to give satisfaction it was removed in January, 1893, and it was temporarily replaced by a bell; but another steam fog signal will be installed there in due time. During the six months or so it was there it was in operation for 93 hours and it burned 1½ tons of coal.

Rear Beacon, Paris Island Range, South Carolina.

This structure was set up and maintained as a light-house in commission at the Centennial Exposition in 1876, at Philadelphia, where it attracted much attention. The tubular foundation of concrete and iron was simulated by a timber structure, properly painted, and on this the structure was erected.

THIMBLE SHOAL LIGHT-HOUSE, HAMPTON ROADS, VIRGINIA. (See p. 243.)

This is a fair specimen of the structure used in rivers and harbors where there is little danger from ice. It stands in 11 feet of water on a screw-pile foundation. The light is about 43 feet above the water, and is visible 13¼ miles. This light is fixed white for 60 seconds, followed by six flashes, alternately white and red, at intervals of 10 seconds. During thick weather its two fog bells are struck simultaneously by machinery every 5 seconds.

It cost about $20,000 to establish this light-house. The consumption of mineral oil here is about 194 gallons a year. Three keepers are employed at this light, who are paid, respectively, $640, $460, and $440 annually.

CAPE HENRY LIGHT-HOUSE.

This structure, which was finished in 1881, is a frustrum of an octagonal pyramid, and stands on the south side of the entrance of Chesapeake Bay, Virginia. It is 157 feet high, and is a fine type of the iron light-house. It consists of an outside shell of cast iron and an inner stair cylinder of wrought iron, the two connected by radial cast-iron abutments. A spiral staircase leads to the lantern. The plates vary in thickness from 1½ inches in the lower sections, weighing about 1,200 pounds, to one-half that thickness in the upper sections. Towers of this kind can be taken down and reerected on other sites. This is sometimes made necessary from the erosion of their sites by the sea. It has been done at several places, notably at Hunting Island, on the coast of South Carolina, and at Cape Canaveral, on the east coast of Florida. Cape Henry light-house carries a first-order light, which is visible 21½ miles. It is a fixed white light, but it shows a sector of red light which covers certain shoals, and thus indicates the dangerous water. It has also a first-class steam siren which, during foggy weather, gives blasts of 5 seconds' duration separated by silent intervals of 90 seconds, thus:

$$\frac{\text{Blast,}}{\text{5 seconds.}} \qquad \frac{\text{Silent interval,}}{\text{90 seconds.}} \qquad \frac{\text{Blast,}}{\text{5 seconds.}} \qquad \frac{\text{Silent interval,}}{\text{90 seconds.}}$$

Three keepers have charge of and reside at this light. The principal keeper's salary is $820 per year; that of the first assistant is $550, and the second assistant has $500 in addition to the use of the keeper's dwelling. As this light-house is near to a much-frequented seaside resort, it is visited yearly by many people.

Cape Henry light-house cost $125,000 to establish. There are 2,248 gallons of mineral oil consumed here yearly. Its fog signal is a first-class steam siren in duplicate. It was in operation for 256 hours during the fiscal year which ended on June 30, 1893, and in that time it consumed 13 tons of coal.

PARIS ISLAND RANGE LIGHT, SEACOAST OF SOUTH CAROLINA. (See p. 244.)

This is the most economical structure of the kind in the history of light-house construction. The plan was born of necessity, it having been found that the appropriation made by Congress was not sufficient to put up the kind of structure which it was usual to place in such a position. The light exhibited is simply a locomotive headlight. It is, however, possible to use on it a lenticular apparatus. The tower is composed of columns, sockets, struts, and tension rods framed in the form of a triangular pyramid. It rests on six circular iron disks, anchored to a concrete foundation. The top sections of the side facing the channel, for which the tower is the guide, are provided with horizontal slats to increase the visibility of the beacon

by day. The light, which runs up and down in the rails of the structure, is housed by day, and at night is hoisted to its place at the apex of the triangle by machinery worked in the oil house. The large foundation plates are about 40 feet 4 inches apart. The focal plane of the light is 120 feet above the sea level, but the top of the structure is 132 feet from the ground. The cost of the ironwork set up is $9,400, and that of the structure complete and lighted about $12,000.

There are 353 gallons of mineral oil consumed here yearly. The two keepers receive each year $560 and $420, respectively.

FOWEY ROCKS LIGHT-HOUSE, FLORIDA REEF.

A description of this structure can be found on a foregoing page.

CLEVELAND LIGHT-HOUSE, OHIO.

This is a fine specimen of the brick tower. Its height from its stone foundation is 83 feet; but as it stands on high ground, the light is 157 feet above the level of Lake Erie. The fixed white light shown was visible rather more than 21 miles. The station was established in 1829; but the present tower was built in 1872. The light was discontinued in 1892 as no longer needed.

The cost of establishing this station was $55,775; it consumed 301 gallons of mineral oil annually, and it had two keepers who received respectively $560 and $450 each year.

CALCASIEU LIGHT-HOUSE.

This light house, located at the entrance to the Calcasieu River, Louisiana, is a specimen of the type of the river and harbor structure placed on screw-pile foundations in the Southern waters where there is no danger from ice. It shows a fixed white fourth-order light 53 feet above the water which is visible about 14¼ miles.

It cost $14,000 to establish this structure; some 204 gallons of mineral oil are yearly consumed here; and the station is cared for by a single keeper who is paid therefor, at the rate of $680 a year.

PIEDRAS BLANCAS LIGHT-HOUSE.

This light-house, which stands on a bluff 80 feet high, overlooking the Pacific Ocean, at the entrance to San Simeon Bay, California, is a fine specimen of the tower used on such elevations. This structure is of brick with iron trimmings. It is 90 feet high and carries a first-order light 170 feet above sea level. The light, which is visible nearly 22 miles, is fixed white, varied by a white flash every 15 seconds.

It cost $90,000 to establish this station; its yearly consumption of mineral oil is about 1,862 gallons. The yearly pay of the three keepers employed here is $800, $600, and $550, respectively.

MARE ISLAND LIGHT-HOUSE.

The Mare Island light-house is a fair type of the harbor light used in many sheltered places. It is at the entrance of Karquines Strait from San Pablo Bay, California. A small square tower, surmounted by a lantern, rises from the roof of the keeper's dwelling. The fourth-order white light, which is 76 feet above the sea level, can be seen 16¼ miles. The fog signal is a bell struck by machinery every 10 seconds.

This station cost $20,000 to establish; it burns 138 gallons of mineral oil each year, and the two keepers here employed receive the one $800, and the other $375 annually.

THE WESTERN RIVER LIGHT.

A good picture of a post light of the kind indicated by the model described on a preceding page, was shown.

LIGHT-HOUSE AT CLEVELAND, OHIO, LAKE ERIE.

FOURTH ORDER LIGHT-HOUSE AT PENFIELD REEF, LONG ISLAND SOUND.

XVI.—Light-House Steam Tenders.

The *Dahlia*, a water color of which was exhibited, shows the average steam light-house tender on the Great Lakes. She is built of iron, is 141 feet 6 inches long, 25 feet wide, and 10 feet 6 inches deep. Her custom-house measurement is 333 tons. She draws 7 feet 6 inches, and cost when completed, furnished, and fully equipped for service, $90,000, the amount appropriated for her construction. The *Dahlia* was built in Philadelphia in 1873-'74 and was brought around through the St. Lawrence and Canadian canals to the lakes. Her sea speed is 9 knots per hour with 25 pounds of steam.

During the summer and fall of 1892, she was employed in delivering fuel, supplies, and rations to the light-ships, light-stations, and fog signals on Lake Michigan. After that, the season being well advanced, she took up all the buoys in Lake Michigan, and then went out of commission and wintered in Chicago. On the opening of navigation in the spring of 1893, she replaced all the buoys in Lake Michigan, and then laid the electric cable and placed the electric buoys on the Chicago water front. Her crew consists of 15 men and 5 officers. The cost of her maintenance for the fiscal year which ended on June 30, 1893, was $16,603.30, including repairs.

There are required for maintaining the efficiency of the Light-House Service, 30 steam tenders, 2 schooners, and 8 steam launches. The seacoasts, the lakes and the great Western rivers are divided into sixteen light-house districts. Each district is under the charge of a light-house inspector who is an officer of the U. S. Navy, and of a light-house engineer, who is an officer of the Corps of Engineers of the U. S. Army. As a rule, each inspector has a steamer which he uses in laying or replacing buoys and in inspecting or supplying light-stations. Each engineer has, when needed, one or more steamers at his control for purposes of construction and repair. The *Dahlia* which was frequently seen at the Casino dock of the Exposition, and the model of which was shown in the light-house indoor exhibit, was a fair specimen of the average light-house tender.

XVII.—Photographs.

Some large framed photographs, measuring 12 by 18 inches, were shown. They were of the following-named stations:

PENFIELD REEF LIGHT-HOUSE.

This light-house stands on a reef about 2 miles from land in Long Island Sound, off Bridgeport Harbor, Connecticut. It was built in 1872-'73, on a riprap foundation 108 feet in diameter at the base and rising up to low-water mark. On this foundation stands a pier 18 feet high, 48½ feet in diameter at the bottom, and 46½ feet at the top. The pier is surmounted by a granite dwelling and tower, from which is shown at 54 feet above sea level a flashing red light which can be seen from a distance of 14¾ miles.

It cost $55,000 to establish this station; 253 gallons of mineral oil are yearly consumed here, and the two assistant keepers receive respectively $600 and $420 per year for their services.

The light serves to guide vessels into Bridgeport Harbor and into the harbor of refuge at Black Rock, Connecticut. It also serves as a coast light for vessels bound up or down Long Island Sound. The fog signal is a Daboll trumpet with blasts of 3 seconds followed by silent intervals of 17 seconds. The trumpet is supplemented by a bell which can be struck by machinery a double blow every 20 seconds. It was in operation 467 hours during the fiscal year which ended June 30, 1893, and burned but 3¼ tons of coal.

The Daboll trumpet was invented by Mr. C. L. Daboll, of Connecticut, who was experimenting to meet the announced wants of the U. S. Light-House Board. The

largest of them consists of a huge trumpet 17 feet long, with a throat 3½ inches in diameter, and a flaring mouth 38 inches across. In the trumpet is a resounding cavity and a tongue-like steel reed 10 inches long, 2¾ inches wide, 1 inch thick at its fixed end and half that at its free end. Air is condensed in a reservoir and driven through the trumpet by hot air or steam machinery at a pressure of from 15 to 20 pounds, and is capable of making a shriek which can be heard at a great distance for a certain number of seconds each minute by about one-quarter of the power expended in the case of the whistle. In certain experiments against, at right angles, and at other angles to the wind, the trumpet stood first and the whistle came next in power. But in the trial of the relative power of various instruments made in 1874, by Gen. Duane, U. S. Army, then light-house engineer, the 12-inch whistle was reported as exceeding the first-class Daboll trumpet. The trumpet has done good work at various British stations, making itself heard from 5 to 10 miles. The engineer in charge of the light-houses of Canada reports that—

"The expense for repairs and the frequent stoppages to make these repairs during the four years they continued in use made them (the trumpets) expensive and unreliable. The frequent stoppages during foggy weather made them sources of danger instead of aids to navigation. The sound of these trumpets has deteriorated during the last year or so."

Gen. Duane, reporting as to his experiments in 1881, says:

"The Daboll trumpet, operated by a caloric engine, should only be employed in exceptional cases, such as at stations where no water can be procured and where from the proximity of other signals it may be necessary to vary the nature of the sound."

Thus it would seem that the Daboll trumpet is an exceptionally fine instrument, producing a sound of great penetration and of sufficient power for ordinary practical use, but that to be kept going it requires skillful management and constant care.

The fog signal in use at Penfield Reef light-station is an improvement on the above-described instrument. It is operated by a Rider hot-air engine, in duplicate. The machinery is so much simplified that the light-keeper readily keeps it in order, and its consumption of fresh water and coal is so small that it is quite economical to run. This last is a point of importance in a station like Penfield Reef, where there is scant room for the storage of fresh water and fuel.

BLOCK ISLAND LIGHT-HOUSE.

The Block Island light-house figured in the photograph is a square brown tower rising from one gable of a gray granite dwelling which stands on a high bluff overlooking the entrance to Long Island Sound. The light, which is 61 feet above sea level and is visible 15½ miles, is fixed white. It was established in 1829, but was rebuilt in 1867. It was placed here to guide vessels clear of the low sand point extending out to sea something more than a mile from the light-house.

It cost $15,000 to establish this station; it consumes 235 gallons of mineral oil each year, and its one keeper receives $560 per year.

NEWPORT HARBOR LIGHT-HOUSE.

Newport Harbor light-house is on Goat Island, Rhode Island. This light was established in 1823, but it was rebuilt in 1865. The white stone tower, 29 feet high, with its attached keeper's dwelling, stands on the end of the breakwater. The occulting fixed white light is described on a foregoing page. It is seen for 15 seconds and eclipsed for 5 seconds, thus exhibiting characteristics which differentiate it from all the other many and varied lights in the harbor, afloat or ashore. It is used to guide vessels through the north entrance to Newport Harbor.

This station cost $6,000 to establish; it consumes yearly about 239 gallons of mineral oil, and its single keeper receives $600 a year for his services.

OLD FIELD POINT LIGHT-HOUSE.

Old Field Point light-house is on the south side of Long Island Sound, nearly opposite Bridgeport, Conn. The fourth-order fixed white light is shown from a square tower rising from the gable end of a gray two-story granite dwelling, which gives it a church-like appearance. The station was established in 1823, but the structure was replaced in 1869 with this unique building. The light is 79 feet above sea level, and is visible for 16½ miles.

It cost $12,000 to establish this station; 151 gallons of mineral oil are burned here each year, and the one keeper employed receives $520 a year.

LITTLE GULL ISLAND LIGHT-HOUSE.

Little Gull Island light-house is located on quite a small rocky islet on the south side of the main easterly entrance to Long Island Sound, where it is within sight of more lights and within earshot of more fog signals perhaps than any other of its importance. The bulk of the commerce which goes through Long Island Sound either way uses it as a guide. The fixed white second-order light, which is visible 19¼ miles, is shown from a gray granite tower 74 feet high; this is connected with a keeper's dwelling of red sandstone, and both stand on a granite pier. Tides and currents run with great swiftness and power through this narrow channel. Many vessels come to grief here. Fogs prevail, and the most perplexing aberration of the audition of fog signals is prevalent in this vicinity. Hence Little Gull Island fog signal has been several times under the observation of scientists who were trying to determine the laws of sound which govern these aberrations, but, unhappily, so far without success.

It cost $22,500 to establish Little Gull Island light-station; 797 gallons of mineral oil are yearly burned here, and the three keepers employed receive respectively $680, $500, and $450 per year.

The steam siren.—The siren, which is the fog signal used at Little Gull Island light-station, was adapted from the instrument invented by Cagniard de la Tour, under the guidance of Prof. Henry, then member of the Light-House Board, when it was adopted for use as a fog signal. The siren consists of a huge trumpet, with a wide mouth and a narrow throat, and is sounded by driving steam through a disk placed in its throat. In this disk are 12 radial slits; back of the fixed disk is a revolving plate containing as many similar openings. The plate is rotated 2,400 times each minute, and each revolution causes the escape and interruption of 12 jets of steam through the openings in the disk and rotating plate. In this way 28,800 vibrations are given during each minute, and as the vibrations are taken up by the trumpet an intense beam of sound is projected from it. The siren can be operated under a pressure of 72 pounds of steam, and may be heard, under favorable circumstances, from 20 to 30 miles. "Its density, quality, pitch, and penetration render it dominant over such other noises after all other signal sounds have succumbed." It is made of various sizes or classes, the number of slits in its throat-disk diminishing with its size. The dimensions given above are those of the largest.

The experiments made by Gen. Duane, U. S. Army, then light-house engineer, with these three machines show that, all other things being equal, the siren can be heard the farthest, the steam whistle stands next to the siren, and the trumpet comes next to the whistle. The machine which makes the most noise consumes the most fuel. From the average of the tests it appears that the power of the first-class siren, the 12-inch whistle, and the first-class Daboll trumpet are thus expressed: Siren 9, whistle 7, trumpet 4; and their relative expenditure of fuel thus: Siren 9, whistle 3, trumpet 1.

Sound signals constitute so large a factor in the safety of the navigator that the cientists attached to the light-house establishments of the various countries have given much attention to their production and perfection, notably Repere in France,

Tyndall in England, and Henry in this country. The success of the United States has been such that other countries have sent commissions here to study our system. That sent by England in 1872, of which Sir Frederick Arrow was chairman and Capt. Webb, R. N., recorder, reported so favorably on it that since then "22 sirens have been placed at the most salient light-houses on the British coasts, and 16 on light-ships moored in position where a guiding signal is of the greatest service to passing navigation."

The trumpet, siren, and whistle are capable of such arrangement of length of blast and interval, and of succession of alternation, as to identify the location of each, so that the mariner can determine his position by these sounds.

In this country there were in operation in July, 1893, one hundred and fourteen fog signals operated by steam or hot air, and the number is to be increased to the urgent demands of commerce.

HUNTING ISLAND LIGHT-HOUSE.

Hunting Island light-house is located off the coast of South Carolina. The conical tower is of cast iron with brick lining. It was originally erected in 1875 on a site fully a quarter of a mile back from the sea. The Light-House Board was then criticised for placing it so far from the water. But the site became so eroded by the action of the waves that it was necessary to take the structure down and reerect it in 1889 at a point a mile and a quarter to the southward. The original cost of the light-house was $102,000; the cost of taking it down and rebuilding it was $51,000. Being built of iron its removal became possible. The light shown is white, of the second order, and flashes every 30 seconds. The tower being 121 feet high and 12 feet above the level of the sea, gives the light a height of 133 feet and makes it visible something more than 20½ miles.

This station burns 470 gallons of oil each year, and it is cared for by three keepers, who receive, respectively, $740, $540, and $490 per year for their services.

FORT SUMTER LIGHT-HOUSE.

Fort Sumter light-house is a white framework 25 feet high, standing on the northwest face of Fort Sumter in the harbor of Charleston, S. C., into which harbor it serves as a guide. It was established in 1855, but it was sadly injured during the late war of the rebellion by the fire of the Confederates on Fort Sumter, and then utterly destroyed by the fire of the Federal guns, it was rebuilt in 1866. The light is 51 feet above sea level and is visible 14¼ miles. It is chiefly notable for what it has suffered and survived.

There are 115 gallons of mineral oil consumed yearly in maintaining this light-station, and its one keeper receives $560 per year for his services.

ST. AUGUSTINE LIGHT-HOUSE. (See p. 251.)

This light-house is on Anastasia Island, near St. Augustine, Fla. Its conical brick tower, 150 feet high, is visible to the mariner for a long distance. As it might be mistaken by day for any of the other high brick towers, the shaft is colored with black and white spiral bands, giving it, as has been said, the appearance of a barber's pole. The tower stands 11 feet above the level of the sea, so that the light is 161 feet above high water, and is visible nearly 21¼ miles. It is a fixed white light, varied by a white flash every 3 minutes.

It cost $105,000 to establish this station; the light consumes about 2,238 gallons of oil a year and the three keepers employed here are paid respectively $720, $500, and $450 for their services.

AMELIA ISLAND LIGHT-HOUSE.

This light-house is a white brick tower 58 feet high which stands on the lowland near the entrance to the harbor of Fernandina, Fla. The light, which

Second Order Light-House at Hunting Island, S. C.

First Order Light House at St. Augustine, Fla.

First Order Light House at St. Augustine, Fla.

is of the third order and flashes white every 90 seconds, is 107 feet above sea level and is visible 18¾ miles. The photograph shows its great use as a day mark for vessels making this landfall.

It cost $17,000 to establish this light-station; 278 gallons of mineral oil are yearly consumed here, and its one keeper is paid at the rate of $660 per year.

ST. JOHNS RIVER LIGHT-HOUSE.

St. Johns River light-house is a brick tower 74 feet high, built in 1859 to replace the old structure which was erected in 1829. It stands on low ground only 3 feet above sea level, near the mouth of St. Johns River. The fixed white third-order light is visible 16¾ miles and is the guide to the many vessels making for Jacksonville, Fla.

It cost $25,000 to establish St. Johns River light-station; 306 gallons of mineral oil are yearly burned here, and the one keeper is paid $660 a year for his services.

SAND KEY LIGHT-HOUSE.

Sand Key light-house is an iron pyramidal framework on a pile foundation inclosing a square dwelling, connected by a cylindrical staircase with a lantern which is 109 feet above sea level. The tower was built in 1853. It stands on a small temporary islet of sand and shells on the Florida Reef, about 7 miles from Key West. The light, which is of the first order, is visible 18¾ miles. It is quite peculiar in its complex and highly useful arrangement, for, in certain directions, it shows fixed white for 60 seconds, varied in the next minute by a white 10-second flash. This is preceded and followed by partial eclipses of 25 seconds. In certain other sectors the light is fixed red for 1 minute and is varied in the next minute by a red 10-second flash, preceded and followed by 25-second partial eclipses. This arrangement, which seems so complicated in description, is quite simple in production. It is, in effect, a plan by which a red light plays with great brilliancy and frequency on the dangerous waters, while the white light constantly indicates the path of safety. This enormous structure stands on the center of Sand Key, but it is only 350 yards from the deep waters of the Gulf of Mexico.

It cost $126,335 to establish Sand Key light-station; 2,211 gallons of mineral oil are yearly consumed here, and the three keepers employed at this isolated station receive $800, $480, and $475 per year, respectively.

GROSSEPOINT LIGHT.

This light is near Evanston, Lake Michigan, about 12 miles north of Chicago. It is shown from a conical brick tower 90 feet high, built in 1873. The light is 119¼ feet above the lake level and is visible 19¼ miles. It is a second-order fixed white light varied by a red flash every 3 minutes. The fog signal is a 10-inch steam whistle which, during fogs, gives a blast of 5 seconds, followed by silent intervals of 20 and 40 seconds, thus:

Blast,	Silent interval,	Blast,	Silent interval,
5 seconds.	20 seconds.	5 seconds.	40 seconds.

The coast light shown from it is of great use to vessels going to and from Chicago.

This station cost $55,000 to establish; it consumes yearly about 781 gallons of mineral oil and it employs three keepers, who receive, respectively, $675, $500, and $425 per year.

The fog signal at Grossepoint is a steam whistle in duplicate. It was in operation during the season of navigation of the fiscal year which ended June 30, 1893, for 504 hours, in which time it consumed 31 tons of coal.

The steam whistle as a fog signal at Grossepoint.—It appears, from the evidence given in 1845, before the select committee raised by the English House of Commons,

that the use of the locomotive whistle as a fog signal was first suggested by Mr. A. Gordon, C. E. But it is conceded that Mr. C. L. Daboll, under the direction of Prof. Henry, and at the instance of the U. S. Light-House Board, first practically used it as a fog signal by erecting one for use at Beavertail Point, in Narragansett Bay. The sounding of the whistle is described "as caused by the vibration of the column of air contained within the bell or dome, the vibration being set up by the impact of a current of steam or air at a high pressure." It is noted that the energy so excited expends its chief force in the immediate vicinity of its source, and may be regarded, therefore, as to some extent wasted. The sound of the whistle, moreover, is diffused equally on all sides. Difference in pitch is obtained by altering the distance between the steam orifice and the rim of the drum. When brought close to each other, say within half an inch, the sound produced is very shrill, but it becomes deeper as the space between the rim and the steam or air orifice is increased.

The steam fog whistle is the same instrument ordinarily used on steamboats and locomotives. It is from 6 to 18 inches in diameter, and is operated by steam under a pressure of from 50 to 100 pounds. An engine takes its steam from the same boiler, and by an automatic arrangement shuts off and turns on the steam by opening and closing its valves at determined times. The machinery is simple, the piston pressure is light, and the engine requires no more skilled attention than does an ordinary stationary engine.

The result of the experiments made by Prof. Henry and Gen. Duane for the U. S. Light-House Board, reported in 1874, goes to show that the steam whistle could be heard far enough for practical use in many positions. Prof. Henry found that he could hear a 6-inch whistle 7¼ miles with a feeble opposing wind. Gen. Duane heard the 10-inch whistle at Cape Elizabeth at his house in Portland, Me., 9 miles distant, whenever it was in operation. He heard it best during a heavy northeast snow-storm, the wind blowing then directly from him, and toward the source of the sound. Gen. Duane also reported that "there are 6 fog signals on the coast of Maine; these have frequently been heard at the distance of 20 miles," which distance he gives as the extreme limit of the 12-inch steam whistle.

SPECTACLE REEF LIGHT-HOUSE.

This light-house is shown by model as well as photograph. An account of the structure is given on a preceding page.

PIGEON POINT LIGHT-HOUSE.

This light-house is shown in two photographs. This structure is situated on the extremity of Pigeon Point, California, overlooking the Pacific, about halfway between the Golden Gate and Monterey Bay. The conical brick tower is 100 feet high, but as it is placed on a 50-foot bluff, the light is 150 feet above the water and is visible 21¼ miles. This first-order light flashes white every 10 seconds. The steam whistles during the fog sound thus:

Blast,	Silent interval,	Blast,	Silent interval,
4 seconds.	7 seconds.	4 seconds.	45 seconds.

This light is of much service to vessels bound north to San Francisco, or going south from the Golden Gate.

Pigeon Point light-station cost $90,000 to establish; it consumes yearly about 1,943 gallons of mineral oil, and it employs four keepers, who receive, respectively, $800, $600, $550, and $500 per year.

The two fog signals used at this station are a 10-inch and a 12-inch steam whistle. The first named is kept in reserve. The 12-inch whistle was in operation 698 hours during the fiscal year which ended on June 30, 1893, and it burned in that time 68 cords of wood.

SCREW-PILE LIGHT-HOUSE.

The screw-pile light-house and the first-class light-ship shown in photographs are both described on preceding pages. A model of the latter was also shown.

STONE DAY BEACON.

The stone day beacon shown in photograph is a fair specimen of such structures. It is a conical stone pier built of six courses of dimension stone upon a riprap foundation. It is 15 feet across at the top and 17 feet across at mean high water. An iron column surmounted by a spherical iron cage rises from the pier. Strongly as these day marks are built, a number of them have been more or less damaged and even overthrown by the irresistible thrust of the ice fields when they move out of harbors. There are more than four hundred day marks of various kinds in service.

LIGHT-STATIONS IN THE FIRST AND SECOND LIGHT-HOUSE DISTRICTS.

Photographs of all the light-stations in the first and second light-house districts were shown, during the last days of the Exposition, in frames hinged to a section of a mast, from which the lens lantern, arranged in groups, for small light-ships, had been shown. These photographs measured 4 by 6 inches; the frames in which they were shown measured 28 by 30 inches. They presented an interesting and consecutive view of the light-houses on the New England coast, showing something of their relation to each other.

XVIII.—Light-House Keepers.

One of the keepers of the Chicago Harbor light-house was on duty in full uniform in connection with the light-house exhibit in the Government building. He will be pleasantly remembered by many visitors for his courtesy, and especially for the intelligent answers he gave to their many questions. This man was a good specimen of his class.

Light-house keepers are appointed by the Secretary of the Treasury on the recommendation of the Light-House Board. The candidate, however, receives at first only an acting appointment. If, after serving some three months, he passes the examination of the officer of the U. S. Navy who is the light-house inspector of that district, the candidate receives a full appointment; failing to pass that examination, he is dropped from the service.

The appointment of light-house keepers is restricted to those who can read, write, keep accounts, are able to do the requisite manual labor, to pull and sail a boat, and have enough mechanical ability to make the necessary minor repairs about the premises, and keep them whitewashed or painted, and in order.

Although but one grade of keeper is recognized by law, usage has divided keepers into a number of grades, with different pay as well as different duties, and with promotion running through various grades. At one light-house there may be but one keeper; at another a principal keeper and an assistant. There is a station where there is a principal keeper with four assistants. The fourth assistant light keeper has the lowest grade and the lowest pay. The others were appointed to the lowest grade and were promoted as merit was shown and vacancies occurred. Or, they may have been transferred and promoted from another station. Although persons are appointed to the service and assigned to a given station, they are transferred from one station to another, as the interest of the service may demand. Young men who have seen some sea service are preferred as assistants at the larger stations. At stations requiring but one keeper, retired sea captains who have families are frequently selected. At those stations where there are fog signals it is customary, however, to have one assistant who is able to operate its machinery and keep it in repair. He is usually one who has a certificate as a steam engineer, and is something of a machinist.

Such persons are graded and paid at a higher rate on their original entry into the service than others.

While many light-stations are located on submarine sites, the greater number of lights have connected with them a little land, which the keepers are encouraged to cultivate. Hence small farms or gardens are often connected with stations, which are cultivated by the keepers' families.

Keepers are forbidden to engage in any business which will prevent their presence at their stations, or the proper and timely performance of their light-house duties. It is no unusual thing to find a keeper working at his station as a shoemaker, tailor, or in some similar capacity. There are light-keepers who fill a neighboring pulpit, others who hold commissions as justices of the peace, and there are still others who do duty as school teachers without neglecting their light-houses. Many persons have continued their professional studies while doing good service as light-house keepers. Among them are several lawyers who now have a high reputation. And there is a judge who dates his taste for admiralty law, and something of his knowledge as to its practice, from what he learned while one of the keepers of a light-house on the Florida reef.

The Light-House Board has done much to make keepers comfortable. They are furnished with quarters for themselves, and in certain cases for their families. When so far distant from market as to make the expense of its carriage exceed its cost, they are furnished with fuel and rations. Suitable boats are provided for stations inaccessible by land; and at those stations on shore distant from markets barns are built for their cattle and horses. Something has also been done for the intellectual needs of the keepers and their families by supplying them with the libraries described on a preceding page.

Light-keepers are, under the law, paid an average sum of $600 a year; but the rates range in individual cases from $100 to $1,000 a year. In March, 1893, Congress appropriated $670,000 for the payment of its 1,150 keepers.

In 1883 the Board prescribed dress and fatigue uniforms for its keepers, and required them to wear one or the other on all proper occasions. This they provide at their own personal cost.

The discipline of the service is somewhat rigid, and has been from the beginning. On December 31, 1806, Mr. Gallatin, then Secretary of the Treasury, placed the following indorsement on a letter:

"The part which relates to the conduct of the keeper of Cape Henry light-house is submitted to the President for his decision."

It was returned indorsed:

"I think the keepers of light-houses should be dismissed for small degrees of remissness, because of the calamities which even these produce, and that the opinion of the collector in this case is of sufficient authority for the removal of the present keeper.

"TH. JEFFERSON."

Now the class of men from whom keepers are selected is so good that the punishment of dismissal is infrequently inflicted. But it follows swiftly in two cases. A keeper found intoxicated is not only summarily dismissed from the service, but he is instantly ejected from the station; and a keeper who allows his light to go out is dismissed without regard to his excuse or his previous good conduct.

The Board holds that it is the duty of every light-keeper to stand by his light as long as the light-house stands. For him to desert it when it is in danger is as cowardly as for a soldier to leave his guns on the advance of an enemy. His failure to keep his light burning, especially in time of danger, may cause the wreck of vessels looking for it and result in the loss of much property and many lives.

Keepers are trained to consider the care of the light and the light-house property their paramount duty, beyond any personal consideration. The *esprit du corps* is such that instances have happened where the keepers on duty have, as in the case

OPEN-AIR EXHIBIT OF THE LIGHT-HOUSE BOARD.

the first light on Minots Ledge, gone down with their light-house and died at ɜir post. In other cases the keeper has saved his lens, letting his family shift for ɜmselves. There are repeated instances where the keeper has saved his light-use property and lost his own. One instance of heroism is that of the keepers of arps Island light-house, in Chesapeake Bay. The structure was lifted from its undation in February, 1881, thrown over on its side, and carried away by ice. The eper and his assistant clung to the floating house, and, although one of their boats nained uninjured, they drifted in the bay 16¼ hours without fire or food, always imminent danger, as the heavy floating ice often piled up against and threatened swamp the house. It grounded, however, full of water, on an island shortly after dnight, at high tide. Satisfied that it would not float off again, soon the two epers got ashore, and when the tide had fallen they returned, saved and took to ɜ shore the lens, its pedestal, the oil, the library (much damaged by water), and even ɜ empty oil cans, and then reported the facts through their inspector to the Board, antime, the keepers of another light-house, fearing the ice, had deserted their st and gone ashore. The fact that no vessels could have needed their light while ɜ ice remained unbroken, and that they returned to their post when the danger d passed did not avail them. So soon as the fact of their desertion was made own to the Board they were dismissed, and the two keepers who had spent those rrible hours afloat in Sharps Island light-house, and then saved its apparatus, re highly complimented by a letter direct from the Board itself, and then were pointed to the deserters' places.

While it is no part of the light-keeper's duty as such to look after wrecks, or to ccor the distressed, many acts of heroism have been performed by keepers of light-uses. In those instances where, in doing so, they have endangered their own res, they have received from the Secretary of the Treasury gold or silver medals proportion to the danger incurred, not as compensation, but rather as marks of preciation for their services.

XIX.—The Open Air Exhibit.

This exhibit of the Light-House Establishment was made on the space allotted for e purpose, located to the eastward of the Government building. It was composed an iron light-house tower and five buoys, all of which were of life-size. Some of em had been in use, and all were ready for use.

THE LIGHT-HOUSE TOWER.

The tower exhibited was built for use at the Waackaack light-station on New ork Bay. The work had been done by contract at Detroit, Mich. As the site was t ready for its erection at the time of its completion, it became possible to exhibit e tower at the Exposition.

The Waackaack light tower is an iron skeleton structure surmounted by a parapet d lantern, accessible from below by a spiral stairway inclosed in an iron cylinder. s height from base to lantern top is 106 feet and its weight is about 150,000 pounds.

The skeleton structure which rests on eight circular foundation disks, anchored to concrete foundation, is composed of columns, sockets, struts, and tension rods, rming the frustum of a square pyramid, bounded on the top by an architrave sup-rting an octagonal gallery, a circular parapet and a decagonal lantern.

The frustum has a base of 28 square feet; its height is 84 feet to the lower face of e architrave, where its sides form a square of 8 feet 8.66 inches on each side.

The contract under which the tower was built provided that—

"The wrought iron to be used for the structure must be free from imperfections, nd must be capable of bearing a tensile strain of not less than 50,000 pounds per uare inch of cross section. All castings must be entirely free from imperfections, ich as honeycomb, blowholes, etc.; they must be straight, out of wind, and must ave a clean and smooth surface. The iron in the castings must be light gray in

color, close grained, and of such quality that a rough bar three-fourth inch squ supported at points 12 inches apart, will break under a load of not less than pounds applied at the center.

"The agent of the Light-House Board in charge of the work may test specim of the iron by straining or breaking, but no piece that has been strained and possi crippled shall be used in the structure. The tests referred to shall be at the exp of the contractor.

"The boltheads and nuts throughout the structure are to be hexagonal, if otherwise specified. The screw threads must be sharp and clean and the bo proper lengths. The diamond checkering, wherever specified, is to be at an angl 30° to one side of the plate, the checkers not being longer than 1¼ inches. brass must contain not less than 90 per cent of copper; it must have a close ture, and no scrap is to be used in the alloy.

"None but the best workmanship will pass inspection."

It was also provided that all portions of the work should be thoroughly inspe at the shops before it was painted, and that the contractor should afford the ag of the Light-House Board every assistance needed in making this inspection.

The contract price was $11,810 for the tower erected in place on its own founda The Government is to furnish the illuminating apparatus, the lantern glass, and prepare the foundation for the reception of the tower.

The tower was visited by many persons, who studied this structure from scie and mechanical points of view.

As soon as the Exposition was closed, the structure was taken down and its p were sent to Waackaack, the place where it has since been erected for light-house

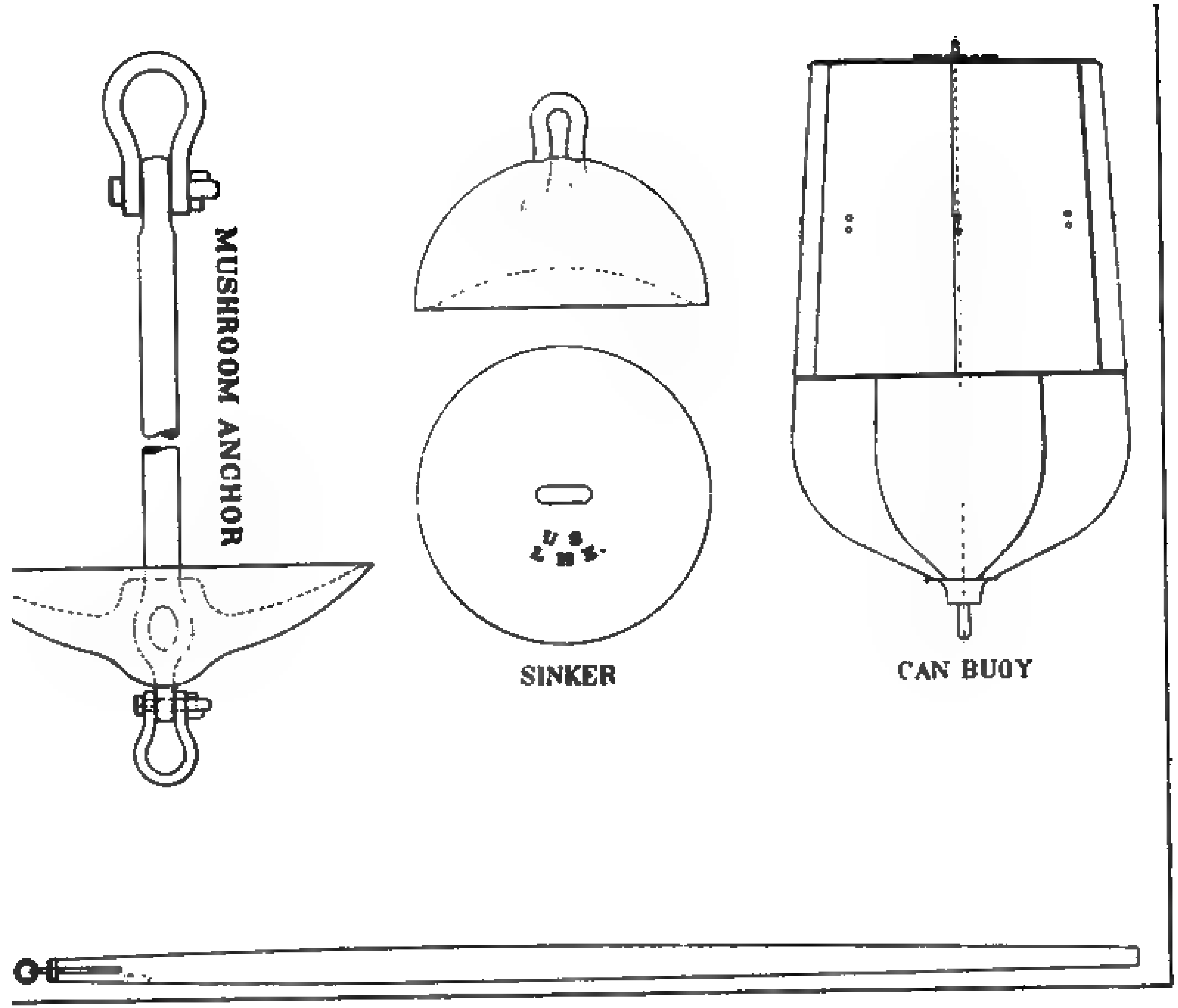
BUOYS.

The buoy is to the seaman by day what the light is at night, and what the signal is in thick weather. It tells him by its size, form, color, and number how avoid rocks and shoals, and shows the way in and out of harbor.

In 1852 the Light-House Board had nearly 1,000 buoys in position; in 1858 it 1,034; in 1860 it had 1,738; during the war of the rebellion it lost those on the South coasts, but in 1867 it had so far replaced and added to them that it had 2,044; 1875 it had 3,002, and on June 30, 1893, it had 4,469 buoys in United States wa An appropriation of $370,000 was made for maintaining the buoyage of the Un States coasts during the year ending June 30, 1894.

The buoy service has its own code of laws, State and national, a fleet of steamers for its maintenance, and a corps of contractors to attend to the buoyag coves and inlets impracticable to the steamers. It has its depots for the storag iron buoys, where they are painted and numbered or repaired, and also where wo buoys are made ready for service. It has its own directory printed yearly, i volumes, distributed gratuitously for the benefit of commerce, in which each of the nearly 5,000 buoys is mentioned by name, located by station, and is descri by size, shape, color, number, and vicinity.

Buoys are of wood or iron. The wooden or spar buoys are logs from 12 to 60 long, of pine, spruce, or cedar, but preferably of cedar. The Board frequently tracts for the delivery, at one of its depots, of a cargo of logs, in the rough, at $10 to $15 each, where they are freed of their bark, smoothed of their protru knots, painted to the pattern required to tell their allotted story, and fitted at larger end with an iron sleeve, to which the stone or iron anchor can be attache a mooring chain. Then they are packed in classes or sizes on skids to season. finally to take their tour of duty in the water to replace others which are to awhile on shore, when they are freed from acquired barnacles, take on a fresh of paint, and, by drying, recover their buoyancy. Spar buoys are classified first length and thickness, and then by acquired color; but they are interchange within these conditions.


MUSHROOM ANCHOR
U S
L H E
SINKER
CAN BUOY

Iron buoys are hollow, with air-tight compartments. They are made of boiler iron, being riveted as are boilers. The three kinds are called nun, can, and ice buoys. The nun buoy is conical in form; the can buoy is so slightly conical that it may almost be regarded as cylindrical in shape; the ice buoy is made much like a spar buoy, of great length, slight thickness, and of largest diameter near its middle. Each shape is classified by size, and diversified by color and number. They were formerly made of wooden staves, like barrels, but their rapid destruction by the *teredo navalis* caused the substitution of boiler iron. The cost of these buoys varies with the price of iron and the cost of labor. The Board's last contract for buoys, with all their attachments, except mooring chains, was made at the following rates:

First-class can buoys, 6 feet across and 9 feet 6 inches high	$172.00
Second-class can buoys, 4 feet 4 inches across and 7 feet high	78.06
Third-class can buoys, 3 feet 2 inches across and 4 feet 10 inches high	37.52
First-class nun buoys	160.00
Second-class nun buoys	69.76
Third-class nun buoys	31.84

A specimen of nun buoy, one of the can buoy and one of the ice buoy, each of full size and each of which had been in use was shown near the light-house tower.

Buoys are exposed to many dangers, not the least of which is that of being run down and ripped open by passing steamers. As the iron buoys are made with compartments, they are rarely sunk, but their line of flotation is often lowered, and their usefulness accordingly decreased. Spar buoys frequently lose a portion of their length, which is cut off by strokes of colliding propeller blades. Despite State and national statutes forbidding it, vessels will sometimes make fast to buoys, thus gradually dragging them off their bearings. A buoy has been set adrift that a reward might be obtained for its recovery; but this is not a profitable operation, as the reward paid is varied with the circumstances of each case.

The buoys' worst enemy, however, is ice moving in mass with a tide or current. A well-made, well-moored buoy, at the mouth of a narrow river can create an ice gorge. But usually, when the ice moves in force, the buoys met have their mooring loops torn out, their mooring chains broken, or their mooring anchors weighed. In each case the buoys are carried out to sea, when the buoy tenders give chase and if successful in their capture return them to position. The sea-going qualities of the large iron buoys are shown by their involuntary voyages. One is now anchored off the coast of Ireland, where it was picked up, about six weeks after it had been wrenched from its place in New York Harbor, and turned over to the Irish light-house establishment, by which it was reported to the U. S. Light-House Board, when it was presented to the Irish board, who simply added to its former marks their own, and moored it near the point where it came ashore, in commemoration of its peculiar voyage.

The importance of keeping New York Harbor and Bay well marked has moved the Light-House Board to keep its iron buoys in position, notwithstanding their danger during the winter. But a spar buoy is placed beside each iron buoy, as the ice that carries away the one passes over the other, and allows it to resume its position and indicate to passing vessels where the iron buoy should be. It also shows the buoy tenders exactly where the buoy is to be replaced. New York Harbor was twice swept clean of iron buoys during one severe winter, and though some of them were recovered, the Light-House Board was put to large expense to replace those which were lost.

The iron ice buoy, a full-sized specimen of which was also shown in the open air exhibit, is made of boiler iron, and is divided into compartments, so that any one may be pierced without sinking the buoy. That of the first class costs $275, and is 50 feet long and stands 22 feet out of water. That of the second class costs $181, is 40 feet long and stands 17 feet out of water. As with wooden spar buoys, the ice passes over them without carrying them away; but, unlike the wooden buoys, they

break the propeller blades which strike them, instead of being broken, and thus, defending themselves, last many times longer than spar buoys. Though costing more at first, iron ice buoys are more economical in the end than are spar buoys of the same sizes.

The whistling buoy of the largest size consists of an iron pear-shaped bulb, 12 feet across at its widest part, and floating 12 feet out of water. Inside the bulb is a tube 33 inches across, extending from the top through the bottom to a depth of 32 feet, into water free from wave motion. The tube is open at its lower end, but projects, air-tight, through the top of the bulb, and is closed with a plate having in it three holes, two for letting the air into the tube and one between the others for letting the air out to work the 10-inch locomotive whistle with which it is surmounted.

FIG. 1.—Courtenay's Whistling Buoy.

These holes are connected with two pipes, with check valves, which lead down to near the water-level, where they pass through a diaphragm which divides the tube into two parts. The great bulb which buoys up the whole mass rises and falls with the waves, carrying the tube up and down with it, thus establishing a piston-and-cylinder movement, the water in the tube acting as an immovable piston, while the tube itself acts as a moving cylinder. Thus the air, admitted through the valves, as the buoy rises on the wave, into the lower part of the tube which is above water, is compressed, and as the buoy falls with the wave it is further compressed and forced through a 2½-inch pipe, which at its apex connects with the whistle. The dimensions of the whistling buoy have recently been much diminished without detracting materially from the volume of sound it produces. It is now made of four sizes. The smallest in our waters has a bulb 6 feet in diameter and a tube 10 feet in length, and weighs but 2,000 pounds. The largest and oldest whistling buoy has a 12-foot bulb, a tube 32 feet long, and weighs 12,000 pounds.

There are now on the coast of the United States 64 of these whistling buoys, which have cost about $1,075 each, but they vary in price according to size. In proportion as they are useful to the mariner, they are obnoxious to the house-dweller within earshot of them; hence the Light-House Board has to weigh the petitions and remon-

strances before setting these buoys off inhabited coasts. They emit an inexpressibly mournful and saddening sound.

The distance at which a whistling buoy can be heard varies with circumstances. A series of observations made as to one off the coast of Maine, in January, 1878, showed that the buoy was heard every day at a station 1½ miles distant; every day but two at one 2½ miles distant; fourteen times at one 7½ miles distant, and four times at one 8½ miles distant. It was heard by pilots of the New York and Boston steamers at a distance of from one-fifth of a mile to 5 miles, and it has frequently been heard at a distance of 9 miles, and even at a distance of 15 miles under specially favorable circumstances.

A large whistling buoy was placed on Outer Diamond Shoal, off Cape Hatteras, North Carolina, where a light-ship was needed, but where none could live. It was well suited for such broken and turbulent waters, as the rougher the sea the louder its sound. But after three buoys had been carried away by the heavy seas, the attempt to keep one there was given up.

The whistling buoy is used to some extent in French, German, and British waters.

The bell buoy.—This sound signal consists of a bell mounted on the bottom part of an iron buoy 6 feet 6 inches across, fitted with a framework of 3-inch angle-iron

FIG. 2.—Brown's Bell Buoy.

9 feet high, to which a 300-pound bell is rigidly attached. A radially grooved iron plate is made fast to the frame under and close to the bell, on which is laid a free cannon-ball. As the buoy rolls on the sea, this ball rolls on the plate, striking some side of the bell at each motion with such force as to cause it to toll.

Like the whistling buoy, the bell buoy sounds loudest when the sea is roughest; but the bell buoy is adapted to shoal water, where the whistling buoy could not ride.

If there is any motion to the sea, the bell buoy will make some sound. Hence the whistling buoy is used in roadsteads and the open sea, while the bell buoy is preferred in harbors, rivers, and the like, where the sound range needed is shorter and the water is smoother.

There are now some 90 bell buoys in United States waters. They cost, with bells, bridles, and ballast balls complete, about $350 each.

These buoys have been improved and simplified of late. The original bell buoy described above was invented by Capt. Henry Brown, of the Light-House Service. In the new buoy shown at the Exposition several cannon balls, confined in tubes placed on several sides of the bell, strike the bell by rolling down through the tube to the bell as the buoy sways with the motion of the waves.

The electric-lighted buoys.—An appropriation of $20,000 was made by Congress in the sundry civil act of March 13, 1893, for "establishing proper buoyage on the water front of Chicago."

It was decided that this should be done with buoys lighted by electricity, that they might be as useful at night as they were by day. As the Light-House Board for some five years had in this way successfully lighted the Gedney Channel from the ocean through New York Bay to New York Harbor, the lighting of the water front of the Exposition with electric buoys was devolved on that body.

The experiment was begun with a high-tension series system, having an alternating current, using a main converter on the shore, and a small shunt coil in the head of each of the buoys. The alternating system as applied was found to be impracticable. Hence the shunt coils were removed and the high-tension series system, with a direct and constant current, was adopted. The Edison lamps on the buoy heads were superseded by 100-candle-power Bernstein lamps.

There were 13 buoys used. They were placed half a mile apart, commencing one-half mile from the Casino wharf and running in a line passing halfway between the outer and inner Hyde Park Shoals, 1¾ miles from shore at the farthest point. Between these shoals they turned at an angle and ran in the direction of Van Buren Street wharf, the last or thirteenth buoy being located one-half mile south of the Chicago South Breakwater.

The buoys were lighted by electricity on the night of July 1, 1893, and they remained in brilliant and successful operation nightly during the continuance of the Exposition.

The cable which was to be attached to the buoys was wound on thirteen different reels, each holding a little more than half a mile of length. The main cable came on three separate reels, and was about 7 miles long. Each length was reeled off from a scow towed from buoy to buoy. The main cable was laid directly from the thirteenth buoy to the Casino wharf. This was laid outside or on the offshore side to prevent it from drifting toward the shore.

The cable used had a length of 13½ miles from the end of the Casino dock to a point within one-half mile of the Van Buren Street dock and back to the point where the land wires of the Exposition formed conductors to the dynamo. The conductor of the cable was made of seven copper wires, No. 16 B. and S., insulated to 0.365 of an inch, covered with three coats of purest, well-seasoned gutta-percha, and served with two coats of fine jute. It was protected on the outside by an armor of sixteen galvanized No. 5 B. and S. wires. This formed a cable of one inch in external diameter, which weighed $1\frac{3}{10}$ pounds to the foot. The copper core was quite flexible; the cable was not liable to kink, and it was easily handled. Its insulation was 1,000 megohms per mile, and its capacity was rated at 0.31 microfarad for the same distance.

At each buoy, at a point 2 feet below the water line, the cable was cut in two and a small insulated rubber conductor spliced in each end of the cable to carry the current to the lamps. This was done to avoid carrying the considerable weight of the cable above the supporting surface of the water, as well as to protect the gutta-percha of the cable from the direct rays of the sun.

This small rubber-insulated conductor was made of twelve copper No. 19 B. and S. wires, covered by a layer of brown rubber, then by white core, and then by a layer of vulcanized rubber. This was served with rubber tape, and the whole with a braid which had been boiled in a waterpoof composition. Its insulation was 2,000 megohms, and its capacity 0.28 microfarad each per mile.

This rubber conductor was laid in a groove in the buoy and protected by battens from outside friction. The rubber-insulated wire was spliced to the main cable by a small copper sleeve. Hot solder, half tin and half lead, was poured over joint. A normal gutta-percha joint was made. This was lapped over with jute, wound with tape, and finally coated with shellac.

The 13 cedar buoys used were of different sizes and lengths, and were adapted to the depth of the water in which each was placed, which ranged from 19 to 30 feet. Seven of these buoys were anchored with cast-iron sinkers, weighing 2,300 pounds each, and the remaining 6 were anchored by sinkers each weighing 1,800 pounds.

Each buoy had a cavity in the side large enough to admit two parts of the cable and allow a batten to fit snugly over after the splices were made. The cable entered the buoy about 3 feet from the heel and passed up its entire length to the lamp in a groove or slot cut in its side for the purpose. An iron ring fitted in the eye of the strap on the buoy was used for lowering the buoy in place with a slip rope. The buoys were fitted and the splices made on the scow.

When this was done the buoys were hoisted from the scow and lowered into place by the derrick of the light-house steamer, which placed them in position.

The electric apparatus was on a switch board in the cable house at the end of the Casino dock. Here was the main converter or transformer, 2 single-pole knife switches, 2 Hill switch-and-fuse boxes, and 2 Wurtz lightning arresters. The electric current was supplied by the Exposition authorities from a 10,000-light Westinghouse dynamo. It was delivered at 2,200 volts and transformed down to 1,460 volts.

The lighted fairway from Chicago to the World's Fair, through somewhat dangerous shoals, did away with all danger of accident by collision or running upon reefs. In fact, the channel was as well pointed out as the pathway in the streets.

XX.—Conclusion.

The light-house exhibit, as a whole, was apparently one of the most interesting of the Exposition. It was always a center of attraction to the general visitor, while engineers and professional men, of this and other countries, and teachers, who visited the fair in great numbers during the summer vacation, were frequent seekers for detailed information.

XXI.—Award.

The chairman of the Executive Committee on Awards of the Board of Management of the World's Columbian Exposition transmitted to the Light-House Board, through the Treasury Department, a paper, a copy of which is subjoined, in which awards are made for certain specified articles contained in the exhibit of the Light-House Board.

[United States. Department G, Transportation. Exhibitor, Treasury Department. Address, ———. Group 85, class 534. Exhibit, "Whistling buoy No. 90, No. 90 gas buoy, buoys, upper end of electric spar buoy."]

AWARD.

When in place it provides a very effective warning to seamen nearing danger in a fog or in gloomy weather. The buoy is of steel, so constructed that it fills itself automatically with air when rising on the wave, and expels it through a powerful whistle when sinking.

D. Mertvago,
Individual Judge.

["Buoys and upper end of electric spar buoy."]

The bell, can, ice, and whistling buoys, and the upper end of electric spar buoy, are all new and first class.

FRANCIS ELGAR,
Individual Judge.

Approved:

H. VON LITTROW,
President Departmental Committee.

Approved:

JOHN BOYD THACHER,
Chairman Executive Committee on Awards.

MARCH 14, 1894.

REPORT OF THE LIGHT-HOUSE BOARD, 1894.

APPENDIX No. IV.

REPORT

UPON THE

CONSTRUCTION OF PIERHEAD CONDUITS

BY

MILTON B. ADAMS,

Major, Corps of Engineers, U. S. Army, Engineer Ninth and Eleventh Light-House Districts.

CONSTRUCTION OF PIERHEAD CONDUITS.

LIGHT-HOUSE ESTABLISHMENT,
OFFICE OF ENGINEER NINTH AND ELEVENTH DISTRICTS,
Detroit, Mich., September 18, 1894.

SIRS: I have the honor to submit the following report concerning the introduction and use of the pierhead conduit, devised by me for use in connection with the lighting of pierheads by means of post lanterns, placed in advance of the usual pierhead beacon and forming therewith a range for approaching a harbor:

The plan is to convey the lantern through a continuous inclosed conduit, made of 1-inch boards measuring 1 foot wide by 2 feet 2 inches high in the clear, so as to allow the ordinary lantern, resting on a small car, to pass through. The conduit is supported at the desired elevation of the light on trestles placed at intervals of 16 feet, securely fastened to the pier timbers at their lower ends. The outer end of the conduit terminates in a box provided with three panes of glass on the front and on either side, forming a lantern having a galvanized sheet iron roof and globe ventilator.

The car with lantern is conveyed back and forth between the beacon tower or fog-signal house, and its position at the outer extremity, by means of an endless cord passing through a sheave or small blocks at the outer end, one-half the cord being supported by small rings (fair-leaders or friction rollers) attached to one side of the conduit near the roof, the other half being connected to the car and allowed to rest on the bottom of the conduit.

The details of the construction are shown on the accompanying drawing, together with sketches showing its application. The arrangement forms a continuous closed channel-way for the lantern, car, and maneuvering cord, completely housing them from the weather, susceptible of operation at all seasons and at considerable distances.

The following conduits have been constructed under the Board's authority at the various localities of the Ninth district, with the lengths at each place:

	Feet.
Manistee, Mich., distance from fog-signal house	290
Muskegon, Mich	580
Grand Haven, Mich	378
Kalamazoo, Mich., no beacon; length of conduit from lamp or cleaning house	240
St. Joseph, Mich	290
Kenosha, Wis	100
Racine, Wis	288
Sheboygan, Wis	264
Kewaunee, Wis	335

The cost of these structures was about $1.02 per linear foot, which included all the necessary work of getting the ballast stone of the cribs out to fasten the trestles, and replacing the stone; also painting the conduit itself (not including trestles, which are rough) two coats of paint.

Only one conduit, that at Kewauneė, has had the test of a winter's season, the others having been placed since spring of this year. They have all worked successfully, and with comparative ease by hand power, excepting one at Muskegon, the longest, which is operated by a small winch.

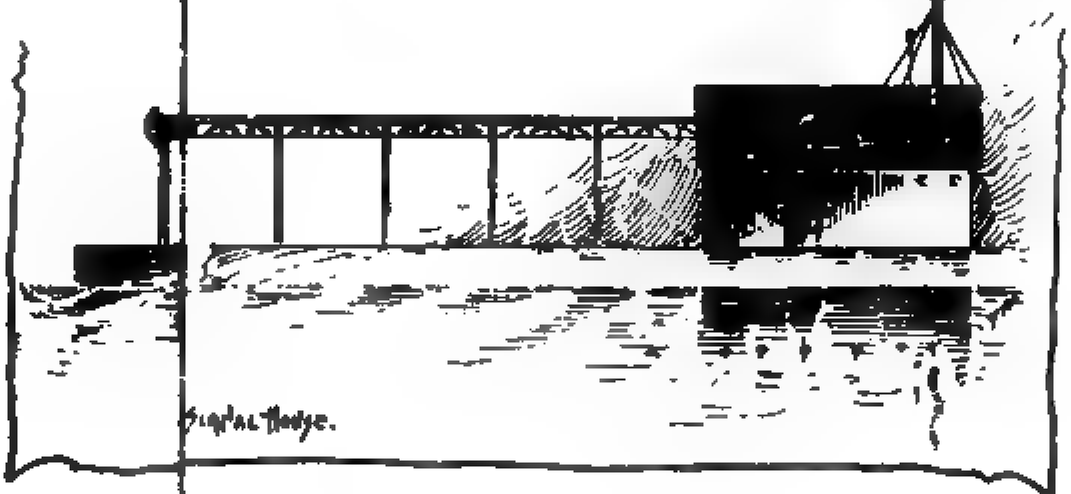
Recent reports from Grand Haven indicate that it may be necessary to place a metal roof to the conduit to insure its being perfectly tight against rain and snow. The estimate received for this purpose will increase the cost 7 cents per linear foot for sheet iron, painted two sides.

The conduit can be added to at any time there is an extension made to the harbor piers, until such time as a limit (probably from 600 to 700 feet) is reached, when it may not be practicable to extend it on account of the amount of power necessary to propel the car. When this limit is reached, and an extension be necessary, it might in many cases be well to move the beacon light also.

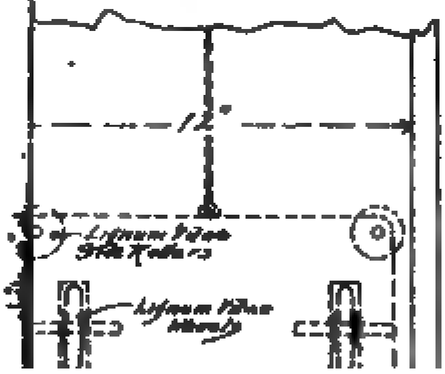
Respectfully.

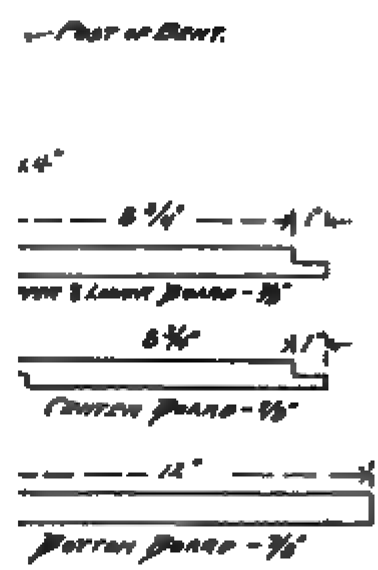
M. B. ADAMS,
Major of Engineers, U. S. Army, Light-House Engineer.

The LIGHT-HOUSE BOARD,
Washington, D. C.

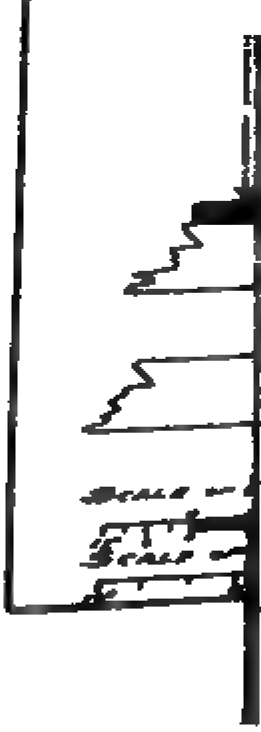


Signal House.

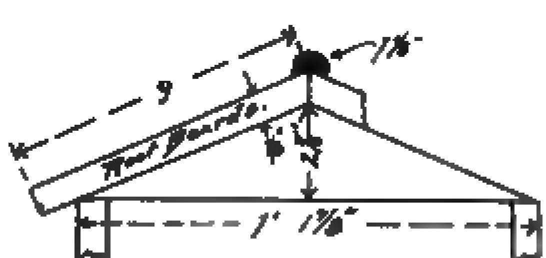




Details of Conduit Boards.



...an of Lantern Box.



Section of Roof.

Office of Light-House Engineer, 11th District,
Detroit, Mich., 1894.
M. B. Adams
Engineer.

REPORT OF THE LIGHT-HOUSE BOARD, 1894.

APPENDIX No. V.

REPORT

JPON

FOG-SIGNAL EXPERIMENTS,

BY

WILLIAM R. LIVERMORE,

Major, Corps of Engineers, U. S. Army, Engineer First and Second Light-House Districts.

LETTER OF TRANSMITTAL.

LIGHT-HOUSE ESTABLISHMENT,
OFFICE OF ENGINEER FIRST AND SECOND DISTRICTS,
Boston, Mass., October 15, 1894.

SIRS: These experiments relate to the distance at which fog signals can be heard, the consumption of fuel, the location to avoid abnormal aberrations, the relative advantages of using air or steam, the rapidity of getting up steam, etc., with a view to the general improvement of the fog-signal system, for which, among other items, the funds of this year were appropriated.

In general terms, sirens and whistles can be heard far enough under favorable circumstances, but the consumption of coal is excessive, involving an enormous expense, not alone in its first cost, but especially in landing and storing it on the exposed shore where most of the light-houses in these districts are located. The Daboll trumpets can generally be heard well enough for the stations where they are placed, but they have been driven by means of caloric engines that are massive and clumsy and very inconvenient to repair. It takes about half an hour to get up an efficient pressure on a trumpet, and an hour on a siren; thus it often happens that the signal is not in operation until nearly an hour after the fog sets in. Bells, which are far more numerous than all the other signals, are now utterly inefficient. Moreover, it often happens that, at all the fog-signal stations, even the most powerful signals are inaudible at very short distances.

Some twenty years ago extensive experiments were undertaken by Gen. Duane, who was then engineer of these districts, and by Prof. Henry, then chairman of the Light-House Board. Gen. Duane estimated the relative powers of the first-class siren, 12-inch whistle, and first-class Daboll trumpet as 9: 7: 4, and the relative expenditure of fuel as 9: 3: 1. Gen. Duane probably took as a standard the distance of audibility. It will appear that, even though the relative power is measured by the square of this distance instead of the first power, the consumption of fuel in the siren is altogether excessive as compared to the trumpet. The records of these districts, however, show a great excess of fuel for both the siren and the whistle taken in comparison with the trumpet. With regard to fog bells, Gen. Duane says:

"A bell, whether operated by hand or machinery, can not be considered an efficient fog signal on the seacoast. In calm weather it can not be heard half the time a greater distance than 1 mile, while in rough weather the noise of the surf will drown its sound to seaward altogether."

The experiments conducted under my charge have in view to ascertain the best means of overcoming the enormous waste of fuel in steam sirens and steam whistles, to increase the range of audibility of trumpets, and to find some better motor than a caloric engine; to see how hard a bell can be struck without breaking it, to increase the sound if possible, to determine the best motive power for striking bells, etc.

All of the comparisons that I have been able to find of the relative power of different fog signals have been made under the most unequal conditions. A siren,

consuming 60 or 70 tons of coal a year, has been compared with a trumpet using 6 or 8 tons, and with a bell struck by machinery with a blow of 8 or 10 foot pounds. No opportunity appears to have been offered to use a larger trumpet or a larger bell or to strike the bell harder. There are no exact determinations to show what pressure is most advantageous, or whether there is any advantage in using compressed air instead of steam to produce the blast. There is no record to show that any trumpets have ever been made large enough to be comparable to a siren, or whether anything would be gained by applying larger horns to the siren to convert more of the force into sonorous vibrations. Absolutely no data could be obtained with regard to the force required to crack a bell, or as to whether the audibility could be materially increased by striking it hard. There were no records to be found in possession of the Light-House Board bearing on these points, nor could any of the bell-makers give us information.

No explanation of the inaudibility of powerful fog signals at short distances has ever been made so clear as to command universal assent, and distinguished physicists have been at variance in assigning a cause to the phenomenon. They have explained the effect of wind and of differences in temperature and humidity in refracting sound, and the effect of differences in the temperature and humidity in reflecting it and breaking it up, but no such measurements of these factors have been made as to show whether they were sufficient to produce the observed effect in any particular case.

It is of the utmost importance that these causes should be well enough understood to guide in the selection of the proper location of fog signals, so as to reduce these aberrations to a minimum, as well as to utilize the sound generated by throwing it in the proper direction, etc. Our experiments are concerned with the topographical position of the signal and its elevation, and with the control of the sound near its origin by the use of reflectors.

Prof. Henry says, in Researches on Sound, pp. 464, 465: "It would appear from these results that while feeble sounds, at small distances, are reflected as rays of light are, waves of powerful sound spread laterally, and even when projected from the mouth of a trumpet tend at a great distance to embrace the whole circle of the horizon." Again, "Upon this and all the subsequent experiments, as it will appear, the principle of reflection as a means of reenforcing sound is but slightly applicable to fog signals." Finally, in his general conclusions, on p. 557: "5. Although sound issuing from the mouth of a trumpet is at first concentrated in a given direction, yet it tends to spread so rapidly that at a distance of three or four miles it fills the whole space of air inclosed within the circuit of the horizon, and is heard behind the trumpet nearly as well as at an equal distance in front of its mouth. This fact precludes the use of concave reflectors as a means of increasing the intensity of sound in a given direction; for although at first they do give an increase of sound in the direction of the axis, it is only for a comparatively short distance."

While our experiments confirm Prof. Henry's facts in general, they by no means lead to his conclusions, for we are convinced that by means of reflectors and large trumpets it is possible to save much sound that otherwise would be broken up and lost. Moreover, if this control were limited to a distance of two or three miles, it would nevertheless be of vital importance to make use of it, since the greatest dangers to navigation are due to the failure of fog signals at short distances; and here the failure of sound is generally relative and not absolute.

Some of the results at the present stage of the investigation may be stated in general terms as follows:

It has been found that the Daboll trumpet can be operated to its full power by a little 2-horse-power steam engine, run by coal or kerosene, as effectively as by the ponderous caloric engine. On some accounts the kerosene engine, without steam, would be preferable to either.

It has been shown that a 1,000-pound bell struck with a 62-pound hammer, with a

force of 180 foot pounds, can be heard under ordinary circumstances from 6 to 8 miles, and usually 3 or 4 miles against a wind of 8 knots an hour. A 4,000-pound bell struck by a 450-pound hammer, with a force of 350 foot pounds, has been distinctly heard at a distance of 12 nautical or 14 statute miles across a gentle breeze. It has been distinctly heard 8 nautical miles against a 10-knot breeze, and at 7 nautical miles with a 16-knot wind blowing diagonally against the sound, whereas the bells now in use, as Gen. Duane says, "can not be heard half the time a greater distance than 1 mile, while in rough weather the noise of the surf will drown its sound to seaward altogether."

The tests of fog signals have been made in connection with the regular work of the tenders on their way to and from light-stations. This data has been collected from time to time, whenever opportunity has presented itself.

The following is a list of the regular fog signals of the First and Second districts which have been tested:

Sirens: First-class, Boston light, Massachusetts; second-class, Cape Elizabeth, Maine.

Whistles: 12-inch, Cape Elizabeth, Maine, and Race Point, Massachusetts; 10-inch, Libby Islands, Petit Manan, Matinicus Rock, Whitehead, and Seguin, Maine; and Cape Ann, Massachusetts.

Trumpets: First class, Manana Island; second-class, Portland Head; third-class, Mount Desert Rock, and Cuckolds, Maine; and Whaleback, New Hampshire.

Bells: Deer Island Thoroughfare, Goose Rocks, Owls Head, Pond Island, and Halfway Rock, Maine; and Eastern Point, Baker Island, and Minots Ledge, Massachusetts.

Several bells were broken in order to determine how heavy a blow could advantageously be given. Three of these were of bell metal, made by the Blake Bell Company, of Boston, Mass.; the fourth of a steel composition made by the Cincinnati Bell Company, of Cincinnati, Ohio.

These bells were mounted on a wooden frame and struck by a heavy hammer. They have been operated by a striking machine attached to a small oil engine. Two bells have been taken about the districts on the tenders and compared with the signals regularly used.

At Boston light-station experimental signals have been set up and several tests made. These include, beside the regular sirens, 12-inch, 10-inch, 8-inch, and 6-inch whistles, mounted at different elevations, a very large Daboll trumpet with such variations as were found necessary on account of its great size. This trumpet has a 10-inch reed. The second-class Daboll trumpet has been supplied with a wooden horn, 55 feet in length, and the effect of this addition carefully noted.

The Shipman and the Kane oil engines have been compared with the motors now in use.

During the winter arrangements were made for testing the sound of signals in the upper regions of the air. The War Department authorized us to use the large balloon belonging to the Signal Service, and a detachment was to have been sent in charge of a signal officer to make the ascensions.

The balloon belonging to the Department of Agriculture was also placed at our service, and Prof. H. A. Hazen, the meteorologist, had kindly consented to cooperate with us. The Secretary of the Treasury also authorized the employment of Mr. Thomas A. Baldwin, of Quincy, Ill., the celebrated aeronaut.

It was proposed to make ascensions from the region in front of the fog signals, where the wind was blowing against the sound, and to determine whether in the upper regions the intensity of sound was diminished by adverse winds. This, it is thought, would finally decide whether physicists are correct in supposing that the sound is refracted upward by an adverse wind.

It was also proposed to experiment in sending sounds through the water from bells, water sirens, etc.

Authority was also given to set up experimental screens at Whitehead and Cape Elizabeth, with a view to controlling the sound. The work in the laboratory, and at the experimental station had progressed far enough to suggest a fog signal of novel construction, perhaps superior to any now in use. During the spring, however, it was decided, at the suggestion of the Board, to suspend for the present any extensive operations, except such as could be conducted in connection with the ordinary work of repairs and inspections. This was partly because funds were in great demand for repairs to fog signals in other districts and partly from the uncertainty of the appropriations for the coming year. Accordingly, several months more will be required to derive the full benefit from our preparations in the laboratory and at the experimental station.

It has always been necessary to keep a force of skilled mechanics on hand in readiness to be sent to stations to make repairs, and while not required for this purpose their odd time has been utilized on these experiments.

The observations on the *Myrtle* and *Clover* have been made partly in connection with the ordinary work of repairs and inspections, but sometimes expressly for this work.

Physicists now agree upon the laws of atmospheric refraction, and reflection, but have no definite knowledge of the application of these laws sufficient to decide when the sound of any individual signal would be heard at a given point.

It is thought that the study of the observations of the past year, taken in connection with previous ones, will furnish the necessary data to explain the greater part, if not all, of the apparent irregularities so far as relate to the stations on the New England coast and to serve as a guide in locating fog signals in the future.

Accordingly, this part of the report has been made full and complete, whereas that relating to experimental work has been confined to a general outline.

In conducting these investigations I am indebted to Capt. F. A. Mahan, the former engineer secretary of the Light-House Board, for the assistance which he rendered me in all my undertakings; to Maj. D. P. Heap, engineer of the Third light-house district, for his cooperation and advice; to the inspectors with whom I have been associated, who have done all in their power to aid and encourage the work; to Mr. A. B. Johnson, chief clerk of the Light-House Board, whose work on the Modern Light-House Service has drawn my attention to many questions involved, and who has furnished me with much information and many important suggestions.

Mr. Royal Luther, the superintendent of construction, has directed many of the experiments, both at the station and on the steamer, and his practical experience in the Light-House Service has been of great value. Mr. J. H. Wallace and Mr. H. C. Bradley have conducted most of the observations, and Mr. Wallace has prepared the report of them under my direction. Mr. E. P. Adams, light-house surveyor, and Mr. A. H. Smith, assistant surveyor; Mr. M. M. Griswold, jr., Mr. A. D. Butterfield, and Mr. John P. Dahlgren have displayed great skill and energy in observing and locating the phenomena.

Mr. S. V. Poor, master machinist, has made many useful suggestions derived from his long familiarity with fog signals. Mr. Poor, Mr. W. H. Larkin, jr., and Mr. M. M. Griswold, jr., have rendered skillful aid in constructing the apparatus, and Mr. Griswold has also conducted the photographing. Capt. Theodore Nickerson and all the officers and crew of the tender *Myrtle* have taken great interest in the work and displayed much skill in carrying it on. Capt. A. A. Owens and the tender *Clover*, with her launches, have also been of great assistance.

Respectfully submitted.

W. R. LIVERMORE,
Major of Engineers, United States Army,
Engineer First and Second Light-House Districts.

The LIGHT-HOUSE BOARD,
Washington, D. C.

Besides the reports of the Light-House Board the following books and papers have been freely consulted and quoted:

Allard, Les Phares.
Airey on Sound.
Beazely on Coast Fog Signals.
Elliot, European Light-House Systems.
Henry on Sound.
Johnson's The Modern Light-House Service.
Rayleigh on Sound.
Tyndall on Sound.

And the following papers:

Johnson, A. B. Cruise of the *Clover*, Science, 1894.
Mohn, H. Studien über Nebelsignale, Annalen der Hydrographie und Maritimer Meteorologie, 1892–'93.
Reynolds, Osborne. Pres. Royal Soc., 1874, London.
Stokes, G. G. Rep. British Association, 1857.
Taylor, W. B. Refraction of Sound, Smithsonian Rep., 1875.
White, C. A. Relation of Sounds of Fog Signals to Other Sounds, Science, 1894.

CONTENTS.

LIST OF PLATES.

REPORT ON FOG-SIGNAL EXPERIMENTS.

I—Former Experiments and Investigations Relating to Fog Signals in America.

The experiments and reports of Gen. Duane are frequently quoted throughout this report.

Prof. Henry says, in the report of the Light-House Board for 1874:*

"As investigations of this kind would require much time and peculiar advantages as to location and mechanical appliances, this matter was referred to Gen. Duane, the engineer in charge of the First and Second light-house districts, who had peculiar facilities near his residence at Portland, Me., in the way of workshops and other conveniences, and who, for his established reputation for ingenuity and practical skill in mechanism, was well qualified for the work. The assignment of Gen. Duane to this duty was made during my absence in Europe in 1870, and, as my vacation in 1871 was devoted to light-house duty in California, I had no opportunity of conferring with him until his experiments were completed. His results, therefore, are entirely independent of those obtained under my direction."

It is to be regretted, however, that Gen. Duane's work should not have continued after the return of Prof. Henry from Europe. His method of investigation was inductive, and many years of systematic experiment and observation are required to produce results of great value in this field. The importance of this work to navigation is so great as to affect the utility of the fog-signal system in general. Although Gen. Duane's work related more especially to the appliance for generating sound, yet his observations on the abnormal range of audibility were very useful in calling attention to the phenomena and suggesting the possible causes. He showed the advantages of striking bells harder and of substituting steam power for caloric engines to compress air for a Daboll trumpet. His conclusions have been verified in almost every respect by our experiments, and may be regarded as the basis of all subsequent work. Gen. Duane explained the influence of difference of temperature in different portions of the air in causing reflection of sound, breaking it up and obstructing it. He showed, too, that when the sound was impeded in the direction of the sea, it had been observed to be much stronger inland. He called attention to the refraction of sound in passing through media of different densities, and that snow, rain, and fog had much less influence than had been generally supposed. Prof. Henry had made such investigations, since 1865, as his time would permit, and continued them from 1872 to 1877.

Gen. Duane was led to believe the direction and force of the wind had much less influence than was generally supposed. This is eminently true of one phenomenon of frequent occurrence on the coast of Maine. In a northeast snowstorm the sound of fog signals is heard better inland than in ordinary weather. He cited as an example the whistle at Cape Elizabeth,† which he says "can always be distinctly

* Henry on Sound, p. 480.

† Henry on Sound, p. 481. (*See* Pl. LIII and LXVII-LXX.)

heard in Portland, a distance of 9 miles, during a northeast snowstorm, the wind blowing a gale directly from Portland toward the whistle." The general phenomenon of audibility against a northeast snowstorm is too well confirmed by evidence to be called in question.

Gen. Duane says further:

"The most perplexing difficulty, however, arises from the fact that the signal often appears to be surrounded by a belt, varying in radius from 1 to 1½ miles, from which the sound appears to be entirely absent. Thus, in moving directly from a station, the sound is audible for the distance of a mile, is then lost for about the same distance, after which it is again distinctly heard for a long time.

"This action is common to all ear signals, and it has at times been observed at all stations, at one of which the signal is situated on a bare rock 20 miles from the mainland, with no surrounding objects to affect the sound."

In commenting on Gen. Duane's statement about the whistle at Cape Elizabeth, Prof. Henry says:*

"In this sentence Gen. Duane certainly does not intend to convey the idea that a signal is frequently heard at a much greater distance against the wind than with it, since this assertion would be at variance with the general experience of mankind; but the word 'frequently' applies to the whistle at Cape Elizabeth, which has been already mentioned as an exceptional case, in which the sound is heard best against the wind during a northeast snowstorm."

Prof. Henry's first explanation was as follows:

"The sound comes to the city in nearly direct opposition to the course of the wind, and the explanation which suggested itself to me was that during the continuance of the storm, while the wind was blowing from the northeast at the surface, there was a current of equal or greater intensity blowing in an opposite direction above, by which the sound was carried in direct opposition to the direction of the surface current.

"The existence of such an upper current is in accordance with the hypothesis of the character of a northeast storm, which sometimes rages for several days at a given point on the coast without being felt more than a few miles in the interior, the air continuously flowing in below and going out above. Indeed, in such cases a break in the clouds reveals the fact of the existence above of a rapid current in the opposite direction. The full significance, however, of this idea did not reveal itself to me until, in searching the bibliography of sound, I found an account of the hypothesis of Prof. Stokes, in the Proceedings of the British Association for 1856,† in which the effect of an upper current in deflecting the wave of sound so as to throw it down upon the ear of the auditor, or directing it upward far above his head, is fully explained." ‡

Prof. Henry also says:

"I differ entirely from Gen. Duane as to the cause of extinction of powerful signals being due to the unequal density of the atmosphere. The velocity of sound is not at all affected by barometric pressure, but if the difference in pressure is caused by a difference in heat, or by the expansive force of vapor mingled with the air, a slight degree of obstruction of sound may be observed. But this, we think, is entirely too minute to produce the results noted by Gen. Duane, while we shall find in the action of the currents of wind above and below, a true and sufficient cause."

Prof. Tyndall, the well-known physicist, and the scientific adviser of the Elder Brethren of the Trinity House, was much impressed with the report of Gen. Duane, which, he justly says,§ "Is marked throughout by fidelity to facts, rare sagacity and soberness of speculation. The last three of the paragraphs just quoted

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*Henry on Sound, p. 470.

† *See* report Brit. Assoc., 1857, p. 22.

‡ *See* "Principles affecting the audibility of fog signals," p. 289.

§ Tyndall on Sound, 3d ed., 1875, p. 17.

exhibit, in my opinion, the only approach to a true explanation of the phenomena which the Washington report reveals." He alludes to the remarks about unequal density of the atmosphere, but his criticism of Prof. Henry is too severe. Both wind and temperature appear to affect the range of audibility, and Prof. Henry's explanation of the northeast storm goes very far toward explaining the phenomenon. Prof. Tyndall says:* "Prof. Henry thus accounts for the fact that the northeast snowstorm renders the sound of the Cape Elizabeth whistle audible at Portland. In the higher regions of the atmosphere he places an ideal wind, blowing in a direction opposed to the real one, which *always* (the italics are Tyndall's) accompanies the latter and which more than neutralizes its action. In speculating thus he bases himself on the reasoning of Prof. Stokes, according to which a sound wave moving against the wind is tilted upward. The upper and opposing wind is invented for the purpose of tilting again the already uplifted sound wave downward.

"Prof. Henry does not explain how the sound-wave recrosses the hostile lower current, nor does he give any definite notion of the conditions under which it can be shown that it will reach the observer.

"This, so far as I know, is the only theoretic gleam cast by the Washington report on the conflicting results which have hitherto rendered experiments on fog signals so bewildering. I fear it is an *ignis fatuus*, instead of a safe guiding light. Prof. Henry, however, boldly applies the hypothesis in a variety of instances. But he dwells with particular emphasis upon a case of nonreciprocity which he considers absolutely fatal to my views regarding the flocculence of the atmosphere. The observation was made on board the steamer *City of Richmond*, during a thick fog in a night of 1872. The vessel was approaching Whitehead† from the southwestward, when, at a distance of about 6 miles from the station, the fog signal, which is a 10-inch steam whistle, was distinctly perceived, and continued to be heard with increasing intensity of sound until within about 3 miles, when the sound suddenly ceased to be heard, and was not perceived again until the vessel approached within a quarter of a mile of the station, although from conclusive evidence, furnished by the keeper, it was shown that the signal had been sounding during the whole time.

"But while the 10-inch shore-signal thus failed to make itself heard at sea, a 6-inch whistle on board the steamer made itself heard on shore. Prof. Henry thus turns this fact against me. 'It is evident,' he writes, 'that this result could not be due to any mottled condition or want of acoustic transparency in the atmosphere, since this would absorb the sound equally in both directions.' Had the observation been made in a still atmosphere, this argument would, at one time, have had great force. But the atmosphere was not still, and a sufficient reason for the observed nonreciprocity is to be found in the recorded fact that the wind was blowing against the shore-signal.

"The clue to all the difficulties and anomalies of this question is to be found in the aerial echoes, the significance of which has been overlooked by Gen. Duane, and misinterpreted by Prof. Henry."

The experiments of Prof. Henry have been very extensive in regard to locality, while Tyndall's were, to a great extent, confined to the station of South Foreland. Henry has also gathered data from other sources and extended observations have been made by district officers from time to time. The observations of Commander Chadwick and those of Mr. Johnson, the chief clerk of the Light-House Board, in the Third district, have been especially valuable when taken in connection with the cruise of the light-house schooner *Clover* during the present year, in which Mr. Johnson was assisted by Dr. White and Prof. Hazen.

The observations in the First and Second districts recorded in the present report are perhaps more numerous than any that have been systematically recorded as yet,

* Tyndall on Sound, 3d ed., p. 18.

† *See* Pls. LII., LXII., LXIII.

and all tend to confirm the view that the wind is by far the most important factor that influences the fluctuations of audibility of the fog signals of the New England coast. The phenomena that are not clearly attributable to the wind are in many cases such as would result from refraction due to temperature and those that accord only with the effect of a flocculent condition of atmosphere are comparatively rare.

In many cases several causes undoubtedly conspire to produce the observed effect. To determine quantitively the refraction or reflection in any case would involve almost innumerable observations of wind and temperature and several simultaneous measurements of the intensity of sound throughout the acoustic field. It is quite practicable, however, to explain in almost every instance how the observed effect might be produced, and it has been the aim of this report to suggest such explanations in the description.

Tyndall's severe criticism has had the effect of throwing discredit on all of Henry's conclusions.

It should be noted, however, that in the case of the northeast snowstorm the upper current is not purely an ideal one. Not only is it highly improbable that the north wind extends to the upper limit of the atmosphere, but his explanation of the meteorological conditions is by no means unreasonable. If, as Tyndall says, Henry "does not explain how the sound wave recrosses the hostile lower current, nor does he give any definite notion of the conditions under which it can be shown that it will reach the observer," yet such conditions are not beyond the reach of comprehension. If we take into account the refraction due to temperature and the lateral spread of sound in connection with the wind refraction above, the combined effect is sufficient to penetrate the hostile lower currents.

Again, if Henry does not fully explain the cause of the silent zone at Whitehead he points out conditions which are capable of explaining it. He thoroughly appreciates the fact that the buildings, rocks, and trees at Whitehead create more friction than the surface of the sea to retard the lower currents and tilt up the sound waves. He also appreciates the effect of the lateral spread of the sound in bringing it back. He does not, however, appear to fully realize the combined effect of these causes. Speaking of Henry and Tyndall, Lord Rayleigh* says:

"It is therefore probable that refraction and acoustical opacity are both concerned in the capricious behavior of fog signals. *A priori*, we should certainly be disposed to attach the greater importance to refraction, and Reynolds† has shown that some of Tyndall's own observations admit of explanation on this principle. A failure in *reciprocity* can only be explained in accordance with the theory of the action of the wind. * * * It may be mentioned that Reynolds agrees with Henry in considering refraction to be the really important cause of disturbance, but further observations are much needed."

Our own observations, taken in connection with former reports, lead us to the following opinion with regard to the phenomenon observed at Whitehead and elsewhere, which Henry thus describes in his final conclusions:

"It frequently happens on a vessel leaving a station that the sound is suddenly lost at a point in its course, and after remaining inaudible some time, is again heard at a greater distance, and is then gradually lost as the distance is further increased."

This phenomenon our observers, for want of a better name, have called "the ghost."

We know of no well recorded instance in which this has been observed, except against the wind, as Henry says. In most cases it probably arises from fluctuations in the wind, and there is good reason to believe that all multiple "ghosts" are due to this cause and not to a continued rebounding of the ray. There is no proof in these cases that when the sound is lost at the vessel it is heard beyond it. But the silent area about a mile from the station can readily be explained by refraction

*Theory of Sound, Vol. II, pp. 124-126.

†On Refraction of Sound by the Atmosphere, by Prof. Osborne Reynolds.

when it is considered that the buildings and sometimes the rocks and trees near the fog signal oppose a much greater resistance to the lower current of air than the surface of the sea opposes. Accordingly the difference in the velocity of the upper and lower currents may be sufficient to tilt the sound ray upward in the vicinity of the signal, whereas farther out to sea this difference may be too slight to prevent the lateral spread from carrying it back to the surface, especially if the sea is cooler than the air. Our observations with toy balloons have shown that in such cases the difference between the wind velocity above and below is much greater near the land than farther out to sea. It is then by no means necessary to assume an upper current blowing in the opposite direction to the lower one to account for the "ghost" by atmospheric refraction and lateral spread. This suggests the advantages of placing the signal as high as possible and out of the way of such obstacles as retard the wind.

With regard to the belt of silence surrounding a fog signal, with a radius of about a mile and an area of audibility outside, we have yet failed to discover any instance in which the abnormal silence had been observed simultaneously on opposite sides of the signal; there is no reason, however, why conditions might not exist that would cause such a phenomenon.

We have observed this abnormal silence south of Whitehead in a south wind, and the next day in a north wind have heard the signal all over the "silent area." Then we have gone to the north of the signal and found a "silent area" there, and have found the same phenomena at other stations.

M. Allard, in his extensive work on light-houses, has devoted a chapter to fog signals, in which he has formulated the results of observation in a clear and concise manner, illustrating the principles by a few simple diagrams and tables.

In a paper on the "Refraction of sound, by William B. Taylor," in the Smithsonian Report for 1875, the ideas of Stokes, Reynolds, and Henry are discussed and illustrated.

Col. Elliot's report on "European light-house systems" gives an account of Tyndall's experiments, and much useful information and many valuable suggestions.

In a lecture at Royal United Service Institute, Mr. Alexander Beazely treats of the same subject.

In his work on the Modern Light-House Service, Mr. Johnson reports the results of his own observations and of all others of which he could find a record from the time of Prof. Henry's death up to the date of publication, in 1890. Mr. Johnson has formulated a number of suggestions * as to what the mariner should do, and what he should not do, when approaching a fog signal, which have been republished and translated into many languages.

As the phenomena observed at Beavertail and Little Gull Island, in the Third district, appeared to be very striking, Mr. Johnson, in 1893, made further observations there on the *Clover*, which he has kindly authorized me to incorporate in my report.

Mr. Johnson was accompanied on the cruise of the *Clover* by Prof. C. A. White, LL. D., the eminent geologist, who since his return has published a most valuable paper on the "Echoes" observed on this cruise, which has received the attention of scientists at home and abroad, and has served to open up a most fertile field of investigation. He was also accompanied by Prof. H. A. Hazen, of the Weather Bureau, who is distinguished by his work in meteorology, and who has had some experience as an aeronaut. He had made arrangements to explore the acoustic field in a balloon belonging to the Department of Agriculture, but most unfortunately, and through no fault of his, the balloon was lost in transportation and not recovered until after his return.

Mr. Johnson has given an account of the cruise of the *Clover* in papers read before the Philosophical Society in Washington. Speaking of silent areas, he says:

* The Modern Light-House Service, p. 85.

"The Light-House Board was considering the matter from a purely practical standpoint. If, it was reasoned, there is a point within earshot of a fog signal where, from any cause, the fog signal can not be heard, then some other signal should be placed at that point, from which vessels can take a fresh departure. Acting upon that idea, investigation was made as to the region about each prominent fog signal which it had been said could not be heard at points where it ought to be heard. In several instances I was sent to such points to make investigation and to report with recommendations. In the summer of 1885 I cruised about Point Judith, R. I., * and the southeast end of Block Island, both at the entrance of Long Island Sound, and about the light-house and fog signal on Little Brewster Island, entrance to Boston Harbor. An area of silence was found and plotted about 1¼ miles south of Point Judith, where the powerful fog signal in operation at Point Judith could not be heard. That area was soon marked by a whistling buoy. A similar area was found and plotted 5 miles from Block Island, and a whistling buoy was placed in the center of that silent spot.

"A curious state of things was found off the light-house on Little Brewster Island, Boston Harbor. Complaint has been made as to the action of the fog signal there, which was a Daboll trumpet, and another and better fog signal was wanted. Some asked for a siren, some for a steam whistle, and some for a larger and better Daboll. So a battery of fog signals, one of each kind, was placed there, and I was appointed, with others, on an informal sort of a board, to ascertain and report which of the three was best adapted to the place. It was found that the siren gave the best effect, and it was duly established there, and is there yet. But it was also found that there were several areas of silence within normal earshot of that fog signal which were constant as to their general position, but which were floating or variable in their actual positions. There were already so many lights, buoys, spindles, etc., in that vicinity it was recommended that no more be established there, lest it cause confusion. It was deemed the most curious concatenation of peculiar phenomena yet met."

Extracts from Dr. White's paper are given on page 302.

The Shipman kerosene engine consumes about nine-tenths of a gallon of oil in striking a bell with a blow of 350 foot-pounds six times a minute.

The Daboll trumpet has given but little trouble in repairs. The difficulty has been with the caloric engines. The trumpets are made in duplicate and the reeds can readily be replaced.

II.—Experiments with Fog Signals at Boston Light-Station and Elsewhere.

The importance of Little Brewster Island as a guide to this harbor makes it a commanding position for a fog signal, and a first-class steam fog siren is established here.†

This is set up in a building east-southeast of the light-house and is directed east by south. It is, in general, as efficient a signal as is known, and can sometimes be heard a distance of 15 to 18 miles, while 10 miles is a fair average, taking all kinds of weather into consideration. Under certain conditions, however, vessels bound into Boston hear the siren at a distance, and lose it on approaching the signal.

This silence has often been observed at and about Harding Ledge,‡ 2¼ miles southeast of Boston light, and near the path of vessels from Cape Cod bound to Boston. It is highly essential that the siren should be audible at this point, yet many a ship has been the victim of this rock on account of the failure to hear the signal.

One of the objects in the experiments at Boston light-station is to penetrate the area in the vicinity of this ledge under all conditions of weather, wind, etc., or to determine whether it is practicable to accomplish this object. From its importance

*Pls. VII, XXXIX, XL, LXXI.
†Pls. LXXI, LXXIII.
‡Pls. IX, X.

as an aid to navigation, and because of its proximity to the engineer's office, a sort of experimental fog-signal station has been established in connection with the regular station, and a battery of signals has been set up. These are either spare signals, to be substituted at any station in case of necessity, or improvements in the regular service, to be tested in comparison with the signals now in use.

The regular fog signals at the station consist of two first-class sirens, one of which may be blown by air pressure by means of the connection between the siren boiler and the air receiver in the experimental building.

Other instruments are placed in a temporary building,* southeast of the siren house on the cliff facing the sea.

The whistles and trumpets have also been blown by compressed air.

The compressor was constructed from an old hoisting engine. The hoisting drum was removed from its shaft and replaced by two eccentrics connected with the pistons of two air cylinders placed directly underneath the shaft. This compressor forces the air through a 3-inch pipe into a locomotive boiler which is used as a receiver. This boiler is also connected by an inch and a half pipe to one of the siren boilers in the siren house. The boiler in the experimental building has a capacity of 90 cubic feet of air and the siren boiler the same, but since the siren boiler is usually two-thirds full of water it does not then contain over 30 cubic feet. The compressor was not designed for a pressure of more than 45 pounds.

The whistles† are of the ordinary locomotive type, 12, 10, and 8 inches in diameter. They are placed on a pipe which leads from the air receiver up the tower on the south side, one between the parapet and lantern deck, one in an elbow in the pipe 50 feet above the ground, and one 20 feet above the ground on a pipe connected with the dome of the air receiver.

There are two trumpets at the station. One, a second-class Daboll trumpet, is placed on the east side of the rain sheds.‡ The brass end of the trumpet is connected directly with a large wooden horn, octagonal in shape, and having a wide flare at the end. The horn is 55 feet long and 25 feet in its greatest diameter, and is pointed east by south. This trumpet is blown by compressed air through a pipe leading from the air receiver in the experimental building. It is manipulated by a hand valve.

The other trumpet has been built on exactly the same principles as the regular Daboll trumpet, the only changes in design being those made necessary by its great weight and size. The design was to build a trumpet whose reed should be twice as wide as the largest in the service.

This trumpet § is placed in a horizontal position and the body terminates in a large horn, which is pointed in a southeasterly direction from the experimental building.

The general dimensions are as follows: The body casting is 5½ feet in length, and weighs some 1,400 pounds. The horn is a cast-iron cone 7 feet in length and 4 feet in its greatest diameter. The reed is 40 inches long, 10 inches wide, and 1¼ inches thick in the heaviest part.

Some of the experimental apparatus has been mounted upon a small scow so that it might be towed out into the stream at will. It includes a small boiler, engine, air compressor, and tank, which are to be used in connection with a Daboll trumpet. A frame suitable for a 1,000-pound bell is also upon the scow, together with an engine which furnishes power for the striking apparatus.

Two kinds of bell metal have been tested; the ordinary composition in the bells cast by the Blake Bell Company, and a composition of steel in that by the Cincinnati Bell Foundry Company, and called the "Blymer" bell. These have all been similarly mounted on wooden frames, and suspended by wrought-iron hangers.

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*Pl. LXXIII.

†Pl. LXXIII.

‡Pl. LXXII.

§Pl. LXXIII.

Five bells have been used thus far in the tests, and they have been classified for convenience, and will hereafter be referred to by name:

Name.	Weight.	Force of blow.	Cast by—
	Pounds.	*Foot pounds.*	
Bell A	960	178	Blake Bell Co.
Bell B	1,040	148	Do.
Bell C	4,000	350	Do.
Bell D	1,000	150	Cincinnati Bell Co.
Bell E	3,000	150	Blake Bell Co.

The striking machine consists of gearing attached to the shaft of a small engine. One gear carries a pin which in revolving strikes an arm attached to the hammer and draws it back against a spring, which when released strikes the blow. The force of the blow is mainly determined by springs attached to the hammer arm, and has been varied from 350 foot pounds for the large bells to 150 for the small bells.

The bells have been struck by cast-iron hammers* weighing from 40 to 400 pounds, and having adjustable striking ends of lignum-vitæ, bell metal, or cast iron. The former proved to be undesirable. The bell metal is probably the best.

The engines used with bells are oil burners. One is a 2-horse-power Shipman engine, the other a 1-horse-power Kane engine.

It will be seen from the report of the observations that these bells develop sound almost equal in penetration to that of the Daboll trumpet, and vastly superior to that of the fog bells now in operation. To test the endurance of the bells, however, they were struck a much heavier blow than is recommended for service. Had the opposite course been pursued, and the experiments commenced with gentle blows, many years would have been required to develop any results.

The steel composition bell (1,000 pounds) broke after 24 blows of 150 foot pounds each. The makers explained, however, that their bell was not calculated for so severe a blow, and suggested that it would be better to compare the sound made by the usual blow. This bell has been recast and set up for further experiment.

The 960-pound-bell A was an old one that had been used for years on a light-ship. It broke after receiving 11,000 blows of 178 foot pounds each.

The 1,040-pound-bell E has received about 11,000 blows of 148 foot pounds each and shows no signs of weakness.

The 4,000-pound-bell C broke after receiving 18,000 blows of 350 foot pounds each. Almost all these blows were struck with a cast-iron hammer of about one-tenth the weight of the bell struck, but for a very few blows a hammer with a lignum-vitæ head was substituted.

The 3,000-pound-bell E received several thousand blows of 350 foot pounds each with a hammer of 400 pounds with a lignum-vitæ end; several thousand more of 250 foot pounds with a cast-iron hammer of 400 pounds; then over 60,000 blows of 150 foot pounds each with a 400-pound hammer with a bell-metal end, making, in all, over 82,000 blows before it broke.

From a comparison of the results it will be seen that a blow of 150 foot pounds applied to the 3,000-pound bell is about one-half of what would probably crack it in 10,000 or 15,000 blows.

It is now proposed to recast the 4,000-pound bell and to test it with a blow of 100 foot pounds. It would probably endure this hammering for several years, if not indefinitely, and, even if it ultimately cracked, the expense of recasting would be very slight.

This bell should give a sound ten or fifteen times as great as an ordinary fog bell, and should be heard four times as far. The sound from the lignum-vitæ hammer is

*Pl. LXXIII.

faint, and appears muffled; that from the bell metal is as sonorous as from the cast iron, and there is every reason to believe that those of a still softer metal would be the best material.

The large Daboll trumpet gives a powerful sound, but as it is now tuned the pitch is too low. It may be some time before the reed is properly tuned.

The trumpet, with the 50-foot extension, gives a very powerful sound along the axis, but it has by no means been perfected as yet.

The whistles have been tested by air and by steam under different pressures and at different elevations, but with no decisive results as yet. The large whistles appear to be stronger than the small ones, but require more steam. High pressure appears to be very necessary for the whistles.

The siren has not yet developed any greater power by substituting air for steam. An extension has been made for the horn of the siren with a view, if possible, to convert more of the power into sound waves, but it has not been tested.

The intensity of all of the signals has been somewhat increased by placing a wide platform or roof directly under the horn, sloping down gently toward the water so as to save the sound that would otherwise be broken up by the rocks in front of the signal. It is proposed to try the effect of directing a horn upward, and covering it with a mushroom or umbrella, as in some of the foreign fog signals. All of the experiments have shown that it is quite practicable by screens to deaden the force of the sound behind the signal, however difficult it may be to reenforce it in front, so that screens could be used to good advantage to prevent sound from spreading inward in the neighborhood of cities, etc.

The kerosene steam engines are, in my judgment, far better than caloric engines, but oil engines without steam, I think, would be preferable to either.

Authority was given last winter to test several types of kerosene engines, but on consultation with the engineer of the Third district it was decided that this test could be made more advantageously at his station.

Either the Grobb or the Hornsby-Acroyd would, I think, answer the purpose very well.

In my annual estimate a year ago I had provided for supplying light-stations with some devices for getting up steam more readily than with the boilers and caloric engines now in use. It was proposed, if suitable arrangements could be made, to provide the steam boilers with an artificial draft, and the caloric engines with air tanks of sufficient strength and capacity to store up air enough to keep the signal in operation while firing up. This method is used in France. There is reason to believe, however, that this object could be better attained by the use of quick-steaming boilers like the Fitzgibbon boiler, and by substituting kerosene engines for caloric engines.

It is proposed to take the scow on which the small trumpet and bell has been mounted to the foot of the high and steep cliff at Great Brewster Island in order to test the lateral spread of sound by observations on the other side of the island, and to tow it to other localities where it is important to investigate the accoustic conditions.

Delicate apparatus have been constructed for measuring intensity of sound by photographic and other methods, both absolutely and by reenforcing the fundamental tone and the harmonics.

A trumpet 7 feet long and with a wide opening has been tested with good results as an ear trumpet. There is no difficulty in reenforcing the sound of a fog signal by such means, but some modifications will be required to deaden extraneous sounds.

Telegraph wires have been set up at Boston light, radiating in all directions from the tower and striking the ground or water at about 200 feet, so as to completely surround the fog signal and to serve as a support for thermometers, aneometers and other instruments.

A small mortar of the pattern employed in the Life-Saving Service was fired wit small charges, and fireworks of all kinds were discharged to test the range of suc sounds.

The sound of paper bombs bursting several hundred feet up in the air appeared t be less affected by an adverse wind than low sounds, but our experiments were n so extensive as to prove this.

The pitch of the fog signals now in operation has been tested whenever practi cable, and experiments have been made to determine the proper note. Three hu dred to 400 complete vibrations per second give the best results. The human e is most sensitive to those notes that lie near the middle of the register.

The extraneous noises that tend to drown the sound have every conceivab pitch. Low notes, however, spread out more rapidly than high ones. Their shado is not so well defined.

Lord Rayleigh's "Theory of Sound" has been of great value in directing th experiments. The works of Helmholtz, Airey, Donkin, Tyndall, König, Bartlet Michie, and others, have been freely consulted.

Our experiments are not far enough advanced to determine relative intensities fog signals with mathematical accuracy, but many comparisons have been ma incidentally to the tests of audibility.

During the fall of 1893 a 1,000-pound bell was mounted on the *Myrtle* and take about to the different stations and rung with a blow of 175 foot pounds. Its soun was compared with that of the 8-inch whistle on the steamer. It was sometim set up by the side of the shore signal for comparison.

At the Boston light-station preparations had been made for more accurate co parisons, when the work was suspended. The range of the sound has heretofore be taken as the standard of comparison, and the table gives a rough estimate of th distance at which each signal can be heard under conditions comparatively favo able and unfavorable.

The estimate agrees very well with that of Gen. Duane.

Table of ranges (approximate).

Signal.	Pressure.	Blow.	Distance. Unfavorable.	Distance. Favorable.
	Lbs.	*Ft. lbs.*	*Miles.*	*Miles.*
1. First-class siren, in axis	55		7	[illegible]
2. Second-class siren	55		4.5	[illegible]
3. 10 and 12 inch whistle	50		5	[illegible]
4. 8-inch whistle	30		2	6
5. Second-class trumpet	4		2.8	11
6. 4,000-pound bell		350	3	[illegible]
7. 1,000-pound bell		175	2	[illegible]
8. 1,000-pound bell		10	0.4	[illegible]

The following table of consumption of fuel has been taken from data furnished b the inspectors. It shows the total number of hours that each fog signal was i operation each year; the total consumption of coal in tons of 2,240 pounds in ru ning the signal, and the consumption per hour.

Owing to the difference in the characteristics, however, this would not afford just comparison. In some the blast is longer and the interval shorter than in other accordingly a column is added to show what the consumption would be if estimat by one hour of the time expended in the blasts.

The last column shows the average consumption for each class of signals.

Consumption of coal, 1893–'94.

Station.	Year.	Signal.	Hours of operation.	Coal consumed.	Coal per hour.	Coal per hour, continuous blast.	Mean.
				Tons.	*Ton.*	*Ton.*	*Ton.*
Boston	1893	First-class siren	467	41.90	.089	.534	.501
Do	1894	......do	709	55.35	.078	.468	
Cape Elizabeth	1893	Second-class siren	705	43.5	.061	.366	.327
Do	1894	......do	787	38	.048	.288	
Race Point	1893	12-inch whistle	753	34.35	.045	.343	.317
Do	1894	......do	593	24.9	.041	.307	
Matinicus	1893	......do	322	14.5	.045	.270	
Do	1893	10-inch whistle	1,406	59.75	.042	.244	.298
Do	1894	......do	1,127	48.5	.043	.258	
West Quoddy	1893	......do	1,165	71.25	.048	.363	
Do	1894	......do	1,327	65.5	.049	.360	
Libby Islands	1893	......do	1,554	85	.054	.202	
Do	1894	......do	1,499	80	.053	.263	
Petit Manan	1893	......do	1,927	69	.035	.210	
Do	1894	......do	1,955	71.5	.036	.216	
Great Duck Island	1893	......do	1,315	56.75	.043	.286	
Do	1894	......do	1,458	59.5	.040	.272	
Whitehead	1893	......do	1,991	61	.030	.229	
Do	1894	......do	2,272	72.75	.032	.240	
Seguin	1893	......do	1,119	50.25	.045	.388	
Do	1894	......do	1,405	60.25	.042	.315	
Cape Ann	1893	......do	590	32.21	.054	.273	
Do	1894	......do	554	36.78	.062	.310	
West Chop	1893	......do	438	22.94	.052	.523	
Do	1894	......do	565	25.44	.045	.450	
Manana Island	1893	First-class trumpet	1,038	13.25	.012	.046	.055
Do	1894	......do	1,181	15.75	.013	.048	
Cape Cod	1893	......do	597	8	.013	.063	
Do	1894	......do	688	9.18	.013	.064	
Portland Head	1893	Second-class trumpet	797	10.5	.013	.078	.074
Do	1894	......do	939	10.5	.011	.067	
Cuckolds	1893	Third-class trumpet	532	3.5	.006	.044	.031
Do	1894	......do	1,009	6.25	.006	.041	
Whaleback	1893	......do	1,061	6.25	.005	.023	
Do	1894	......do	947	5.5	.005	.023	
Mount Desert	1893	......do	1,433	7.25	.005	.028	
Do	1894	......do	1,379	6	.004	.029	

III.—Principles Affecting the Audibility of Fog Signals.

From the discussion of the observations made in the present year in the First and Second districts it will appear that there are few of the phenomena that can not be explained upon the principles that are now generally recognized. It is not always practicable to state precisely how much of the apparent irregularity in the audibility of a fog signal is actually due to one cause and how much to another. Such determinations would require almost innumerable observations in all the surrounding region of the condition of the atmosphere and of all the attendant circumstances. The observations have, however, in most cases been sufficient to show that the sound acted as should be expected from the known data.

The following are the conditions which tend to modify the regular audition:

A. Influence of Permanent Obstacles.

(1) Intervening obstacles between the signal and the ear, in general, tend to diminish the intensity of the sound. They do not necessarily destroy it altogether, even if they cut off completely the view of the signal house and its surroundings. On the other hand, they weaken it more or less when near the line, even if the signal is visible from the point of observation. In every case the acoustic shadow is limited by a penumbra in which the sound diminishes in intensity as the straight line joining the observer and the signal approaches the obstacle and does not become absolutely extinguished when it passes through the obstacle.

(2) Irregular surfaces near the signal cause reflection and interference of sound that tend to diminish it materially.

(3) Obstacles behind or on one side of a signal, and very near it, may be so disposed as to cut off the sound in this direction, and if large enough can even make it inaudible at any considerable distance.

(4) Obstacles neither too near nor too far from the signal may cut off the sound in the immediate shadow, although it may be heard at a greater distance where the ray of sound can travel with less curvature.

(5) Regular surfaces that reflect the sound may tend to increase it or to transmit it as an echo to an area from which the direct sound is cut off. Owing, however, to the great length of a wave of sound compared with a wave of light, all phenomena of reflection are much less marked. Most objects in the neighborhood of a fog signal that are large enough to cause a definite reflection are of irregular shape, and the echoes from them are comparatively feeble and rarely tend to reenforce the direct sound very much. It is hardly possible, as some have suggested, that buildings or rocks could present regular surfaces so exactly disposed as to produce absolute interference of sound at a distance, like the optical phenomena of dark bands or rings.

(6) The buildings and natural objects near a fog signal not only affect the propagation of sound by the interposition of their own surfaces, but also by the effect they produce upon the surrounding air, causing currents of different direction, velocity, temperature, etc. These are explained in the next section.

B. INFLUENCE OF ATMOSPHERIC CONDITIONS.

The sound reaches the ear through the air, and the chief causes of irregularity are found in the varying velocity and temperature of its currents, causing the sound wave to be reflected or refracted. It has been stated repeatedly, and confirmed by sufficient observations, that fog, rain, snow, etc., do not of themselves obstruct the passage of sound. They may tend to increase or diminish its intensity, according as they affect the temperature or velocity of the air.

(1) When sound passes suddenly from hot to cold air, or from cold to hot air, it loses some of its intensity, and if it passes through a number of such changes it may be wholly lost in regions where it would otherwise be heard. This is shown by calculation and experiment. It was pointed out by Gen. Duane, and has been made a subject of much study by Tyndall, the English physicist, who speaks of the effect of "flocculent" air in destroying sound. Apart from the absolute obstruction of sound, however, there is often considerable variation in the "acoustic transparency" of the air. Sound is generally transmitted better in cold than in warm air, because it is more homogeneous; for the same reason it is generally transmitted better through a fog, because when the air is near the point of saturation a slight change in temperature might cause so much evaporation or condensation as to reduce its range by one half.* Snow falling through the air acts in a similar way to check the minute currents and eddies.†

(2) Sound passing from a region of high to one of low barometric pressure loses none of its force, but in passing in the contrary direction the force is perceptibly diminished.

Great fluctuations of pressure can not exist in the free atmosphere, but these effects are found in and near the wind instruments that produce the sound.

(3) A most important effect of the air on sound is, however, due to refraction from variations in the wind, heat, and moisture. Whenever the velocity of sound is greater in any part of the air than in that immediately above it the front of a vertical wave of sound becomes inclined, and it is said that the sound "ray" is tilted upward. It is convenient to speak of "rays" of sound suggesting a parallel with

*Thomson Manchester Memoirs, 1861-62, quoted by Lord Rayleigh; Theory of Sound, Vol. II, p. 126.

†Aerial echoes have been observed and discussed by Tyndall and others, and properly referred to the flocculent condition of the air. It is not clear, however, that echoes could not be generated in homogeneous air.

rays of light, although the propagation of sound can not be treated so simply as that of light in the problems of geometrical optics. Light is there considered as though it were propagated only along certain lines that are straight in a homogeneous medium and curved or broken in passing from one medium to another of different optical character.

All light propagated in other directions is neglected because all beams or pencils of light are much wider and longer than a wave length, and therefore most of the light is lost by interference excepting what passes in the direction of the rays. So great is the velocity of light, also, that the motion of the medium is generally neglected in comparison with it, and under these conditions it is fair to assume that the rays along which it is propagated are perpendicular to the wave front.

Sound, however, travels only about one hundred times as fast as a lively wind, and the wave length is as great as the width of the aperture of the trumpet; accordingly it is not all thrown out in the direction of the axis, as the rays of light from a lens or reflector, but spreads out on every side by diffraction. The effect of large obstacles upon these sound waves has been explained above. In considering the phenomenon of refraction of sound, it is to be borne in mind that the sound ray is simply the line along which the sound travels with comparatively little diminution of intensity except what is due to the acoustic opacity of the air, and to the expansion of the wave.

It would be foreign to the purpose of this report to discuss the fundamental principles of wave motion. They are treated satisfactorily in the elementary text-books on mathematical physics.*

On the other hand the analysis of all the phenomena that result from the combined action of wind and temperature on a beam or pencil of sound, or on a wave limited by an obstacle on one or more sides, presents a vast field for mathematical investigation. Lord Rayleigh has outlined the subject in his masterly work on the "Theory of Sound." To extend it further experiment must go hand in hand with calculation. The general form of the wave front is easy to calculate, but the perturbations around the edges are very complicated.

Some approximate notion, however, may be formed by assuming at first that sound travels with normal intensity in a ray perpendicular to the wave front in a moving medium as well as in one at rest, and that when an obstacle intervenes all sound is lost except in the direction of these rays.

The sound generated by diffraction may then be treated comprehensively as the "lateral spreading." This is all that is necessary to determine approximately the amount of curvature given to a ray of sound by difference of temperature and wind.

To ascertain whether an observed aberration in the audibility of a fog signal could be caused by refraction, it is not essential to know whether a horizontal ray would be deflected upward or downward a foot or two more or less at a distance of 2 or 3 miles; it is, however, very important to know whether the total deflection here would be a foot or a mile.

Prof. Reynolds and Lord Rayleigh have both made such simplifications in the problem, and their results agree substantially with our own, in which the subject has been approached from a different point of view. We have, therefore, preferred to make use of their well-known formulæ, so far as they answer our purposes, rather than introduce some that we had made independently and that are not so simple.

These approximations are applicable to rays that are nearly horizontal, and it is with such rays that we have to deal. Considering the sound to be propagated in rays normal to the wave front, the phenomena can readily be explained by simple geometrical diagrams.

Sound travels a little more rapidly in hot than in cold air, in wet than in dry air; a little more rapidly with the wind than against it.

* Bartlett's Mechanics of Molecules; Airey on Sound; Michie's Wave Motion.

Suppose a ray of sound to proceed horizontally from its source. The wave front is then vertical. If it comes into a region of still air in which the temperature or moisture decreases upward it moves faster than the ray above it, the wave front above it is tilted backward and ray is tilted upward. The same effect is produced if it enters a region in which the wind is blowing stronger against the sound above than below, or stronger with the sound below than above.

If the ray traverses a region where these conditions obtain throughout, it is curved upward at every point. Opposite conditions tend to curve the ray downward. The rays above and below the horizontal are curved in precisely the same manner.

The upper regions of the air are usually cooler and dryer than the lower regions. When the wind blows over the rough surface of the earth the lowest stratum is retarded by friction, and the velocity is less than that of the stratum above it.

A difference of a degree Fahrenheit in temperature corresponds in effect with a difference in wind velocity of one foot per second. The effect of humidity, however, is very slight in comparison with wind or temperature.

If the wind blows with or against the sound, with equal velocity above and below, it has no effect on the direction of the ray. On the New England coast the upward refraction is more noticeable when the sound travels against a southerly wind, for then the temperature generally decreases upward more rapidly than with a northeast wind, and this is just the wind to bring foggy weather. In a northeast snowstorm the air at the surface is cold and the retarding influence of friction against the wind does not, perhaps, extend very high.

The effect of the curvature of the rays on the propagation of sound may be illustrated by the diagrams of Pl. 1. The vertical scale has been exaggerated, and no attempt has been made to construct the curves with mathematical accuracy.

The direction of the wind is shown by arrows, and its relative velocity in different regions by the length of these arrows.

In the first, second, and third cases the wind is blowing against the sound and is stronger above than below.

In the fourth case it is blowing with the sound and stronger above than below.

In the fifth case against the sound and stronger above than below, near the signal, but with equal velocity farther from it. This might arise from the friction of the wind against the shore near the station, the sea being too smooth to retard the lower current enough to make it weaker than the upper.

Supposing the fog signal at *FS* and the vessel at *V*. In the first case all the rays below *a* strike the water and are reflected upward or broken up. All rays above *a* are not obstructed. *a* strikes the water at *V*, the signal is heard in the upper regions above *Va*, and owing to the lateral spread of the sound it is also heard less distinctly as far as the dotted line below *a*. It is not heard by a vessel at *W*, but is heard as it approaches *V*, first aloft and then on deck.

In the second case the signal is higher and not only all above *a* pass unobstructed, but all between *a* and *b*. The signal is heard clearly at *U* and *V*, and less distinctly at *W*.

In the third case the signal is as high as in the second but is set back from the edge of a cliff so that even the ray *a* is obstructed and all the rays are tilted up into the air. The signal can not be heard directly anywhere on this line, and the only sound that reaches the vessel is due a little to lateral spread or echoes from the land or the atmosphere.

In the fourth case, on the contrary, the ray is tilted down, and there is no distance at which some ray does not reach the surface.

In the fifth case the ray is tilted up, as in the first case, as far as a point between *U* and *V*. Beyond that point the rays are nearly straight, but the lateral spreading is not counteracted by refraction. The signal is heard at *V*, lost at *W*, and heard again at *X*.

If the refraction is upward in the lower regions and downward in the upper regions, it is difficult to formulate a general statement that will cover all cases. The subject has been discussed, however, by Prof. Henry and by Mr. W. B. Taylor, and Tyndall's criticism of Henry's statements has been quoted above.

A violent wind in any direction tends to break up the sound.

The following computations have been made, under my direction, by Mr. Harry C. Bradley, assistant light-house surveyor.

MATHEMATICAL ANALYSIS OF REFRACTION OF SOUND.

It has already been stated that refraction of the rays of sound may be due to any one of three causes—namely, the variation, with the elevation, of the velocity of the wind, of the temperature of the air, and of the humidity or amount of water vapor in the atmosphere. The object of this discussion is to derive mathematical formulæ for calculating the amount of refraction resulting from known or assumed distribution of wind velocity, temperature, and humidity.

At the outset, it must be noted that, owing to the much greater length of sound waves as compared with light waves, sound does not travel in such definite rays as light. A sound shadow is by no means as sharp as a light shadow, because secondary or diverging waves are thrown off, which tend to fill any gaps.

In this connection Prof. Osborne Reynolds, in a paper which appeared in the Proceedings of the Royal Society of London, 1874, says:

"This phenomenon of divergence presents many difficulties, and has only as yet been dealt with for particular cases. It may, however, be assumed, from what is known respecting it, that in the case of sound being lifted up from the ground by refraction, or, what is nearly the same thing, passing directly over the crest of a hill so that the ground falls away rapidly from the rays of sound, diverging waves would be thrown off very rapidly at first and for a considerable distance, depending upon the wave length of the sound, but as the sound proceeds further the diverging rays would gradually become fainter and more nearly parallel to the direct rays, until at a sufficient distance they would practically cease to exist, or, at any rate, be no greater than those which cause the different refraction bands in a pencil of light."

Refraction of sound by wind.—The effect of a wind blowing with different velocities at different elevations seems to have been first pointed out by Prof. G. G. Stokes in 1857 (see British Association Report for 1857, Trans. Sects., p. 22), but he gives no formulæ or numerical results.

Prof. Reynolds, in the paper above quoted, says:

"If the variation in the speed of the wind were uniform from the surface upward, then the rays of sound would at first move upward, very nearly in circles. The radii of these circles may be shown to be $1{,}100 \times \frac{h}{v_1 - v_2}$, where v_1 and v_2 are the velocities of the wind in feet per second at elevations differing by h feet. In fact, however, the variation is greatest at the ground, and diminishes as we proceed upward, so that the actual path would be more that of a parabola."

Prof. Reynolds used 1,100 feet per second as the velocity of sound.

Lord Rayleigh, in the Theory of Sound (vol. 2, sec. 289), treats the matter of the refraction of sound by wind in the following manner. He takes the case in which the direction of the wind and the ray are in the same vertical plane. "If θ be the angle of incidence, which is also the angle between the plane of the wave and the surface of separation, U be the velocity of the air in that direction which makes the smaller angle with the ray, and V be the common velocity of propagation, the velocity of the trace of the plane of the wave on the surface of separation is—

$$\frac{V}{\sin\theta} + U$$

"which quantity is unchanged by refraction. If the wind velocity vary continuously, the course of a ray may be calculated from the condition that the expression remains constant."

Lord Rayleigh performs the integration and shows the curve to be a catenary. It will, however, for purposes of comparison, be convenient to integrate the expression in a manner different from that employed by Lord Rayleigh, changing the symbols somewhat.

Call φ the angle with the horizontal. As θ is the angle with the vertical, $\varphi = 90° - \theta$.

Take x in a horizontal direction and y in a vertical. Assume that the wind blows horizontally and increases in velocity at the uniform rate of 1 foot per second for every h feet of ascent. Then, if y be measured from the level of no wind velocity, and the sound travel against the wind, the velocity of the wind $U = -\frac{y}{h}$. For V, the velocity of sound, write v. The expression given by Lord Rayleigh then becomes

$$v \sec \varphi \frac{y}{h} = c$$

where c is a constant.

Integrating, and putting $vh = a$ (see Note 1) gives

$$y + \text{constant} = \tfrac{1}{2} a \left(e^{\frac{x}{a}} + e^{\frac{-x}{a}} \right)$$

which is the equation of a catenary.

The radius of curvature of this catenary at its vertex is $\rho = a = vh$. Allowing for the difference in notation, this is the same as the radius of the circle given by Prof. Reynolds.

Prof. H. Mohn, in an article "Annalen der Hydrographie und Maritimen Meteorologie" for March, 1892, figures out the refraction of sound rays due to the combined action of wind, temperature, and humidity, by making the assumption that the velocity of sound diminishes uniformly upward. The resultant curve is a circle. Considering, in his result, that the wind is the only refracting cause at work, the radius of the circle which is horizonal at the origin is $vh = a$, or the same as given by Prof. Reynolds. But the assumption that the velocity of sound diminishes uniformly upward is obviously not likely to be realized. It is, however, approximately true for rays proceeding in a nearly horizontal direction, and at a not very great elevation from the surface, as Dr. Mohn thoroughly comprehends, for he confines his attention and the use of his formulæ to just such rays. His results are very convenient to use, and, within the limits named, are quite accurate. They will be considered again in connection with the temperature investigations.

Prof. Mohn also obtains, as a sufficiently accurate approximation to his circle, the parabola

$$y = \frac{x^2}{2a}$$

In order to show how close all these curves which have been spoken of—the circle, the parabola, and the catenary—agree with each other and with a curve described below, the following calculation has been made. Assuming that the wind increases in velocity 1 foot per second for 100 feet elevation, $h = 100$, $v = 1,120$, $a = 112,000$; then for a distance $x = 4$ nautical miles, the elevation y becomes

	Feet
Parabola	2,637.9
Catenary	2,647.3
Curve $y = a \log \sec \frac{x}{a}$	2,658.0
Circle	2,668.8

The curve $y = a \log \sec \frac{x}{a}$ will be seen later to be the curve which represents the refraction due to temperature and humidity. As it represents closely all the other curves, and as, moreover, it is a practical convenience in computing refraction due to the combined action of two or more causes to have all the refraction curves alike, the curve will be taken to represent refraction by wind also.

If y be differentiated with respect to x,

$$\frac{dy}{dx} = \tan \varphi = \tan \frac{x}{a}$$

Hence φ (in circular measure) $= \frac{x}{a}$, and the equation of the curve may be written $y = a \log \sec \varphi$.

This equation represents the ray of sound which is horizontal at the origin. (If $x = 0$, $\varphi = 0$.) To obtain the curve for a ray starting at an inclination θ with the horizontal, transfer the origin along the curve to the point where $\varphi = \theta$. (See note 3.)

$$y = a \log \sec \left(\frac{x}{a} + \theta \right) - a \log \sec \theta$$

Now, for some numerical results, to give an idea as to how much tilting of sound rays is produced by a wind blowing directly against them, the following table has been calculated, assuming $r = 1,120$, for rays starting horizontally, and for winds increasing from 1 to 8 feet per 100 feet of elevation. The distances x are given in nautical miles, the elevation in feet.

	1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.
1:100	165	661	1,490	2,660	4,170	6,040	8,280
2:100	330	1,330	3,020	5,450	8,670		
3·100	497	2,010	4,640	8,530			
4.100	665	2,720	6,390				
5:100	835	3,470	8,360				
6:100	1,010	4,260					
7:100	1,180	5,120					
8·100	1,360	6,050					

Thus, with a wind whose velocity increases 1 foot with every 100 feet of elevation, a ray of sound will rise 6,040 feet = about 1 nautical mile, in going a distance of 6 miles. The velocity of the wind at this elevation will be greater than that at the lower elevation by 60.4 feet per second = about 36 miles per hour.

If the ray does not start horizontally, the following table gives the ordinates for the case where the wind velocity increases 1 foot per 100 feet of elevation ($a = 112,000$), for different values of the initial inclination.

	1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.	8 m.	9 m.
−5°	−366	−402	−108	518	1,470	2,780	4,430	6,440	8,820
−4	−260	−189	211	945	2,010	3,430	5,190	7,320	
−3	−153	23	530	1,370	2,550	4,080	5,960	8,210	
−2	−47	235	850	1,800	3,090	4,730	6,730	9,100	
−1	59	448	1,170	2,230	3,630	5,380	7,500		
0	165	661	1,490	2,660	4,170	6,040	8,280		
1	271	874	1,810	3,090	4,720	6,700	9,060		
2	377	1,090	2,130	3,520	5,270	7,370			
3	484	1,300	2,460	3,960	5,820	8,040			
4	591	1,520	2,780	4,400	6,370	8,710			
5	698	1,730	3,110	4,840	6,930				
6	806	1,950	3,440	5,280	7,490				
7	914	2,170	3,770	5,730	8,060				
8	1,020	2,390	4,100	6,180	8,630				
9	1,130	2,610	4,440	6,640	9,210				
10	1,240	2,830	4,780	7,100					
11	1,350	3,060	5,120	7,560					
12	1,470	3,280	5,470	8,030					
13	1,580	3,510	5,820	8,500					
14	1,690	3,740	6,170	8,980					
15	1,810	3,980	6,530	9,470					
16	1,920	4,210	6,890						
17	2,040	4,450	7,260						
18	2,160	4,700	7,630						
19	2,280	4,940	8,000						
20	2,400	5,190	8,390						

If the source of sound be elevated so that some of the rays start downward, it is easy to obtain the horizontal distance that a ray starting against the wind with a downward inclination would travel before it commenced to rise, and also the greatest vertical distance that it descends. The original equations of the curve give at once $x = a\,\theta$, $y = a \log \sec \theta$.

The following table has been calculated as an illustration, using $a = 112{,}000$, and equal increments of 1° 01′ 23″.

θ			x	y
°	′	″	*Feet.*	*Feet.*
1	01	23	2,000	17.9
2	02	46	4,000	71.4
3	04	09	6,000	161
4	05	32	8,000	286
5	06	55	10,000	447
6	08	18	12,000	644
7	09	41	14,000	877
8	11	04	16,000	1,147
9	12	27	18,000	1,453
10	13	50	20,000	1,795

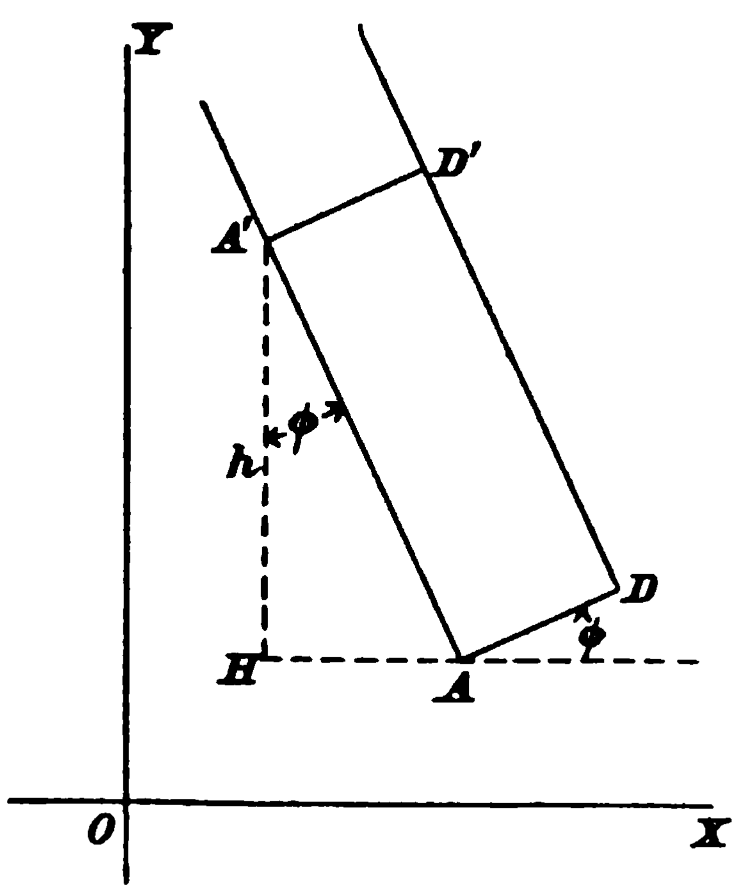
For any value of a different from 112,000, the values of x and y will bear the same proportion to those in the above table that the value of a does to 112,000.

If the wind is not blowing directly against the sound, as has been assumed heretofore, the refraction may be approximately calculated in the following manner: Call w the horizontal angle between the wind and the sound ray, and assume that the effect of the wind varies as $\cos w$, being nothing when $w = 90°$, or the sound travels directly across the wind. Then the parameter—

$$a = \frac{vh}{\cos w} = vh \sec w$$

After determining the parameter a the refraction may be computed as before.

The temperature of the air is usually less above than at the earth's surface. As other things being equal, sound travels faster in warm than in cold air, the effect of this diminution of temperature is to refract the sound ray upward. For the purpose of discussion, assume that the temperature falls 1° F. per h feet of ascent, the layers of equal temperature being horizontal.



Take, as before, OX horizontal, OY vertical. Take ρ a portion AA' of a wave front, where $A'H = h$, so that the temperature at A' is 1° cooler than at A. Now, the velocity of sound is proportional to the square root of the absolute temperature; hence if τ be the absolute temperature at A, $v = c\sqrt{\tau}$ and $AD = c\sqrt{\tau}\,.\,dt$, c being some constant. At A', $v' = c\sqrt{\tau - 1}$ and $A'D' = c\sqrt{\tau - 1}\,.\,dt$. Hence, if ρ is the radius of curvature at the point A,

$$\rho : \rho - AA' = AD : A'D'$$

$$\rho : \rho - h \sec \varphi = c\sqrt{\tau}\,.\,dt : c\sqrt{\tau - 1}\,.\,dt$$

Solving for ρ

$$\rho = \frac{h\sqrt{\tau}}{\sqrt{\tau} - \sqrt{\tau - 1}} \sec \varphi$$

or, calling the constant coefficient of $\sec \varphi$, a, gives $\rho = a \sec \varphi$.

The integral of this equation (see note 2) is $y = a \log \sec \dfrac{x}{a}$

The value of a for this curve we find to be,

$$a = h\frac{\sqrt{r}}{\sqrt{r}-\sqrt{r-1}} = h\,(r+\sqrt{r^2-r})$$

or, almost exactly, $a = h\,(2r - 0.5)$.

At a temperature of 62° F., $2r - 0.5 = 1{,}045$, hence $a = 1{,}045\,h$.

The following table has been calculated for $h = 200$ feet, and $h = 100$ feet. The distances are in nautical miles, while the elevations are in feet:

	1 : 200	1 : 100
	Feet.	*Feet.*
x=1 m..	88	177
2 m..	354	708
3 m..	796	1,598
4 m..	1,416	2,852
5 m..	2,216	4,480
6 m..	3,196	6,492
7 m..	4,358	8,905

Since the value of $a = 104{,}500$ for a temperature diminishing 1 degree for 100 feet rise is so near the value $a = 112{,}000$ for a wind increasing 1 foot per second for the same rise, we arrive at a rule which may be roughly stated thus: A degree of temperature equals a foot of wind. The exact, but more cumbersome, statement is : A difference of a degree of temperature refracts a ray of sound as much as a difference in velocity of wind of 1 foot per second. While the short phrase is easiest to remember, it must not be forgotten what it stands for. The relation is convenient, but only roughly approximate.

For a ray starting at an inclination θ with the horizontal, the equation is, as before (see note 3),

$$y = a \log \sec\left(\frac{x}{a}+\theta\right) - a \log \sec \theta$$

From the original expression for the radius of curvature it follows at once that at the origin $\rho = a \sec \theta$.

This shows that the centers of all the curves, as they start from the origin, lie in a horizontal plane distant a above the origin. It is interesting to remark in this connection that Prof. Mohn observed of his circles that their "centers all lie at a constant distance from the horizontal plane through the source of sound."

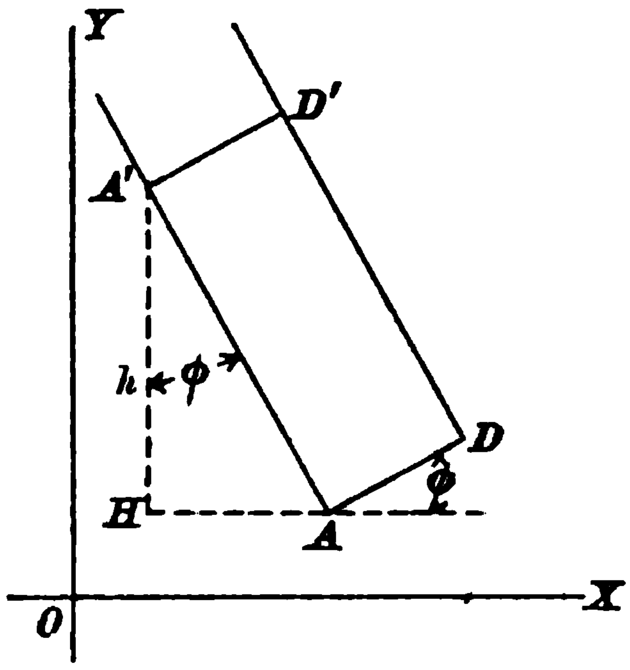
The first reference to the effect of temperature as a refractor of sound seems to have been made by Prof. Reynolds, in 1874, in the paper already referred to. He uses a circle as the curve, and obtains the radius very simply by considering that every degree of temperature between 32° and 70° adds approximately 1 foot per second to the velocity of sound; hence the refractive effect of a degree of temperature is the same as that of a foot per second velocity of wind. This agrees with what has just been found.

Lord Rayleigh obtains a catenary as an approximation to the curve for refraction caused by diminution of the temperature upward.

Refraction of sound by variations of relative humidity.—There is always water vapor present in the air near the surface of the earth, while at a sufficient elevation it entirely disappears. The effect of vapor upon the transmission of sound is comparatively slight, and the refraction caused by it is very small compared with that which may be produced by either wind or temperature. It will be sufficient to assume that, as the amount of water vapor in the air diminishes with elevation, its effect is to increase the density or weight of a cubic foot of the atmosphere uniformly with ascent—increase, because water vapor is lighter than air, and the more of it in a cubic foot the less the weight.

If p is the atmospheric pressure in pounds per square inch, the weight of 1 cubic foot of dry air in pk pounds, where k is some constant whose value it is not necessary to determine, and the weight of 1 cubic foot of saturated water vapor is $p\,(0.6223k)$. If e is the pressure of the vapor actually present in the air in pounds square inch, the weight of 1 cubic foot of moist air is $(p-e)\,k+e\,(0.6223k)=(p-0.3777e)\,k=w$. Now, if at an elevation h the vapor tension has diminished by 0.01 pounds per square inch the weight of a cubic foot of air has become $(p-e+0.01)\,k+(e-0.01)\,(0.6223k)=(p-0.3777e+0.003777)\,k=w'$.

Now, the velocity of sound in air is inversely proportional to the square root of the density w of the air, or $v=\frac{c}{\sqrt{w}}$. Hence, exactly as in the case of temperature,



$$AD=\frac{c}{\sqrt{w}}\,dt, \qquad A'D'=\frac{c}{\sqrt{w'}}\,dt$$

$$\rho : \rho - AA' = AD : AD'$$

$$\rho : \rho - h\sec\phi = \frac{c}{\sqrt{w}}\,dt : \frac{c}{\sqrt{w'}}\,dt.$$

Whence

$$\rho = h\,\frac{\sqrt{w'}}{\sqrt{w'}-\sqrt{w}}\,\sec\phi = a\sec\phi.$$

Hence the curve is

$$y = a\log\sec\frac{x}{a}$$

the same as for temperature.

Substituting for w and w' their values, gives,

$$a=h\,\frac{\sqrt{p-0.3777e+0.003777}}{\sqrt{p-0.3777e+0.003777}-\sqrt{p-0.3777e}}$$

the constant k disappearing. This reduces almost exactly to—

$$a=h\left(\frac{2p}{0.003777}-200e+\tfrac{3}{2}\right)$$

Owing to the very large value that a usually has in this case, it will be sufficient to treat the expression in the parenthesis as constant. Assuming $p=14.697$ pounds per square inch, or the average atmospheric pressure, and assuming a 60 per cent relative humidity of 62° F., which makes e about 0.16 pounds, gives $a=7750\,h$.

For a numerical example, consider in the above-given case, where $e=0.16$ at the surface, that dryness is reached at 3,200 feet elevation. Then $h=200$ and $a=1{,}550{,}000$.

x	y
	Feet.
1 m	12
2 m	48
3 m	107
4 m	191
5 m	298
6 m	429
7 m	584

When the value of a for humidity is compared with that for wind, it appears that a diminution in vapor tension of 0.01 pound in 100 feet is equivalent in refractive power to an increase of 1 foot per second of wind velocity in $\frac{7750}{1120}\times 100=692$ feet.

A change from complete saturation to complete dryness is equivalent to the following increase in wind velocity:

At 32° F., 1.3 feet per second.
47° F., 2.3 feet per second.
62° F., 4.0 feet per second.
77° F., 6.6 feet per second.
92° F., 10.7 feet per second.

This shows the comparatively small effect of the water vapor at ordinary temperatures.

Prof. Reynolds remarks that the velocity of sound "increases with the quantity of moisture in the air; but the quantity is at all times too small to produce an appreciable result," and he does not consider the matter further.

Lord Rayleigh makes no mention of refraction by humidity, but Professor Mohn takes account of it in deriving his formulæ.

Resultant refraction.—It has thus been shown that a sound ray, starting horizontal, is refracted upward by any one of three causes—a wind whose velocity increases upward blowing against it, a fall in temperature upward, or a fall in vapor tension upward—and that in each case the form of the curve is practically the same, depending only on the parameter a. Consequently, if all these three causes act in concert, in order to determine the amount of refraction it is only necessary to have a means of determining the parameter a.

The values of a for each cause acting separately have already been determined to be as follows:

Wind, $a = 1120\ h.\ \sec.\ w.$
Temperature, $a = 1045\ h.$
Humidity, $a = 7750\ h.$

The intrinsic equation of the curve which may be used for all these is $\rho = a \sec \phi$, ρ being the radius of curvature. The amount of curvature at a point determined by the angle $\phi = \beta$ is the reciprocal of the radius of curvature, or $\frac{1}{\rho} = \sigma = \frac{1}{a} \cos \beta$.

The amount of curvature due to each of these causes is thus:

Wind, $\sigma_w = 0.000893 \frac{1}{h} \cos w. \cos \beta.$

Temperature, $\sigma_t = 0.000957 \frac{1}{h} \cos \beta.$

Humidity, $\sigma_h = 0.000129 \frac{1}{h} \cos \beta.$

For wind, h = vertical distance in which velocity of wind increases 1 foot per second; hence $\frac{1}{h}$ amount of increase in velocity of wind per foot of elevation. Call this Δw. For temperature h = vertical distance in which temperature falls 1°; hence fall for 1 foot $= \Delta t = \frac{1}{h}$. For humidity, h = vertical distance in which vapor tension falls 0.01 pound, hence fall for 1 foot $= \Delta e = 0.01 \frac{1}{h}$ and $100 \Delta e = \frac{1}{h}$.

Consequently the curvature due to each cause alone may be written:

Wind, $\sigma_w = 0.000893\ \Delta w. \cos w. \cos \beta.$
Temperature, $\sigma_t = 0.000957\ \Delta t. \cos \beta.$
Humidity, $\sigma_h = 0.0129\ \Delta e. \cos \beta.$

Then the total curvature is the sum of these three, or $\sigma = 0.000893\ \Delta w. \cos w. \cos \beta + 0.000957\ \Delta t. \cos \beta + 0.0129\ \Delta e. \cos \beta$. But the curvature $\sigma = \frac{1}{a} \cos \beta$. Hence $\frac{1}{a} = 0.000893\ \Delta w. \cos w + 0.000957\ \Delta t + 0.0129\ \Delta e$ and

$$a = \frac{1}{0.000893\ \Delta w \cos w + 0.000957\ \Delta t + 0.0129\ \Delta e}$$

Having the value of a for any given conditions, the amount of refraction may be determined by the formulæ already obtained.

In getting the value of a, careful attention must be paid to the algebraic signs of the different terms. The four quantities, Δw, Δt, Δe, and $\cos w$, have been taken positive for definite conditions, namely: The velocity of the wind increasing overhead, the temperature and vapor tension diminishing overhead, and the sound proceeding against the wind. If any of these conditions is reversed the corresponding term must be made negative; this is, if the wind is less in velocity overhead, Δw is negative; if the sound is going in the direction of the wind, $\cos w$ is negative; if the temperature increases overhead, Δt is negative; and if the vapor tension increases overhead, Δe is negative.

When a is positive the refraction curve is concave upward and the refraction tends to elevate the sound ray; but if a, by reversal of one or all the conditions becomes negative, the refraction curve becomes concave downward and the sound rays are brought down by refraction. On the leeward side of the source of sound $\cos w$ is negative; hence a is negative and the action of the wind is to bring down the rays of sound to the ground.

Total reflection of sound by wind.—The following action, which may take place on the leeward side of the source of a sound, is pointed out by Lord Rayleigh in his Theory of Sound, vol. 2, sec. 289. Putting in place of a its value vh, and neglecting the negative sign that merely shows the direction of curvature, the refraction curve gives $y = vh \log \sec \varphi$.

Now call $\frac{y}{h} = U =$ the amount of wind velocity at elevation h, then $U = v \log \sec \varphi$.

At the elevation where U has this value the ray which started with upward inclination φ with the horizontal has become horizontal, and hence will rise no higher, but will begin to descend. A ray will consequently not penetrate a wind whose velocity is greater than U, but will be totally reflected by it.

In the following table v has been taken at 1,120 feet per second and U is given in nautical miles per hour:

Degrees.	Knots.	Degrees.	Knots.
5	2.5	14	20.0
8	6.5	15	23.0
10	10.2	18	33.3
11	12.3	20	41.3
12	14.7	25	65.4
13	17.2	30	95.8

This table shows, for instance, that all rays whose upward inclination is less than 12° are totally reflected by a wind of the same azimuth moving at the moderate speed of 15 miles per hour. In this connection Lord Rayleigh says:

"The effect of such a wind on the propagation of sound can not fail to be very important. Over the surface of still water, sound moving to leeward, being confined between parallel reflecting planes, diverges in two dimensions only, and may therefore be heard at distances far greater than would otherwise be possible. Another possible effect of the reflector overhead is to render sounds audible which in still air would be intercepted by hills or other objects intervening. For the production of these phenomena it is not necessary that there be absence of wind at the source of sound, but merely that the difference of velocities attain a sufficient value."

Reflection of sound by increase of temperature.—If the temperature is higher overhead than at the surface, the refraction curve is concave downward. A sudden rise of temperature will cause a reflection of sound rays in a manner similar to the action of the wind just discussed. As before, $y = a \log \sec \varphi = 1{,}045\ h \log \sec \varphi$.

Call $\frac{y}{h} = T =$ change in temperature in degrees; then $T = 1{,}045 \log \sec \varphi$.

If a ray start upward with inclination φ it will become horizontal by the time the temperature has risen T° and will begin to descend; hence it will not penetrate, but will be totally reflected by a sudden rise of T° or more.

The following table gives numerical results:

Angle.	Temperature.	Angle.	Temperature.
°	°	°	°
2	0.64	8	10.2
3	1.43	9	12.9
4	2.55	10	16.0
5	3.98	11	19.4
6	5.74	12	23.1
7	7.82		

A rise of temperature of 4° F. will turn downward all those rays which started upward at a less inclination than 5°.

Reflection of sound by increase of humidity.—It is also possible to turn a sound ray downward by an increase in vapor tension. If E is expressed in pounds per square inch, $E = 77.50 \log \sec \varphi$, or, in tabular form,

Angle.	Pounds.	Temp. F.	Angle.	Pounds.	Temp. F.
		°			°
1	0.012	−12	6	0.426	75
2	0.047	17½	7	0.580	84½
3	0.106	36½	8	0.758	93
4	0.189	52	9	0.960	101
5	0.295	64	10	1.186	108

The last column gives the minimum temperature consistent with the vapor tension in the second column, or the temperature at which air containing that amount of vapor is saturated. This shows that if the relative humidity rise from 0 to 100 at temperature 64° all those rays which started upward at an inclination less than 5° will be returned to the surface. As another instance, if at temperature 62° the relative humidity rises from 50 to 90, or from 60 to 100, all rays which started upward at angles less than 3° will be reflected.

NOTE 1.—To integrate

$$v \sec \varphi - \frac{y}{h} = c$$

calling $vh = a$,

$$y = vh \sec \varphi - ch = a \sec \varphi - \text{constant}.$$

Differentiate with respect to x,

$$\frac{dy}{dx} = \tan \varphi = a \sec \varphi \tan \varphi \frac{d\varphi}{dx}$$

$$dx = a \sec \varphi \, d\varphi$$

Integrating, and omitting the arbitrary constant,

$$x = a \log (\sec \varphi + \tan \varphi)$$

Whence

$$e^{\frac{x}{a}} = \sec \varphi + \tan \varphi$$

$$e^{\frac{-x}{a}} = \sec \varphi - \tan \varphi$$

and

$$\sec \varphi = \tfrac{1}{2}\left(e^{\frac{x}{a}} + e^{\frac{-x}{a}} \right)$$

But

$$\sec \varphi = \frac{y + \text{constant}}{a}$$

hence

$$y + \text{constant} = \tfrac{1}{2} a \left(e^{\frac{x}{a}} + e^{\frac{-x}{a}} \right)$$

NOTE 2.—To integrate

$$\rho = a \sec \varphi$$

Now

$$\rho = \frac{ds}{d\varphi}$$

$$ds = dy \cos c$$

$$\therefore \frac{d\varphi}{dy} \cos c\, \varphi = a \sec \varphi$$

$$\therefore \frac{d\varphi}{dy} = a \tan \varphi$$

$$\therefore y = a \log \sec \varphi$$

$$ds = dx\, a \sec \varphi$$

$$\therefore \frac{d\varphi}{dx} \sec \varphi = a \sec \varphi$$

$$\therefore \frac{d\varphi}{dx} = a$$

$$\therefore x = a\varphi,\ \varphi = \frac{x}{a}$$

Hence

$$y = a \log \sec \frac{x}{a}$$

NOTE 3.—To transfer the origin of the above curve to the point where $\varphi = \theta$. At this point

$$x' = a\theta$$
$$y' = a \log \sec \theta$$

which gives

$$y + a \log \sec \theta = a \log \sec \left(\frac{x}{a} + \theta \right)$$

Whence

$$y = a \log \sec \left(\frac{x}{a} + \theta \right) - a \log \sec \theta$$

EXTRACTS FROM THE PAPER OF PROF. CHARLES A. WHITE, LL. D., ON THE RELATION OF THE SOUNDS OF FOG SIGNALS TO OTHER SOUNDS.

It is now generally known that within the range of possible audibility of most if not all the fog signals which the various civilized governments have established along their coasts, each usually in connection with a light-house, there are certain areas within which the sound of these signals is inaudible. It is also known that areas of more or less complete inaudibility of sounds, when projected from certain directions, sometimes occur upon the land, but only those which occur upon the water will be specially referred to in this article, and they will be discussed only with reference to their relation to stationary fog signals. Such acoustic conditions being a constant menace to navigation during a fog, the various governments concerned have instituted inquiry into the character and limitations of those areas, and incidentally into their causes. Our own Government has been and still is active in experimental studies of this kind, but the records do not show that any of these studies have been more than incidentally directed to that particular phase of the subject which is indicated by the title of this article.

The areas of inaudibility referred to are of two kinds, each area of both kinds bearing a similar special relation to a neighboring fog signal. One of these kinds is made such in every case by a true acoustic shadow of a stationary visible object, usually a small elevated island, or a ridge of land running out into the water at or near one side of which the fog signal is located. That is, such an area is simply one which an essentially permanent acoustic shadow occupies.

The areas of inaudibility of the other kind occur in broad open waters. There is never any visible indication of their presence, and in connection with or near none

of them is there any visible object above the water surface, and therefore nothing which could cast a true acoustic shadow there. Whatever may be the cause or causes of inaudibility of the sounds of the neighboring fog signal in areas of this kind, it is evident that at least a considerable part of the acoustic conditions prevailing in them are in effect identical with conditions which characterize the other kind. That is, certain of the effects produced within these areas are the same as those which are produced by a true acoustic shadow in each of the first-mentioned kind of areas.

It is impracticable to discuss these areas and to compare each kind with the other without applying to each kind a distinctive name. I have therefore selected for the first-mentioned kind the name montumbral, and for the second, the name pseudumbral, areas. The first name is selected because the areas to which it is applied are in every case made such by the acoustic shadow of a hill or ridge. The second name is selected because the acoustic conditions which prevail in the kind of areas to which it is applied are, as has just been mentioned, largely identical with those which are produced in the other kind by true acoustic shadows.

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The facts now to be mentioned are suggestive of dangers to navigation to be avoided or guarded against. Last autumn, while a member of the party of investigation whose operations were described by Mr. A. B. Johnson in Science for January 5 of the present year, I made some observations of the echoes of the sounds of fog signals which are of special interest in this connection. The most important of these observations were made upon Great Gull Island, at the eastern end of Long Island Sound, and the echoes were those of the fog signal, a siren, which is connected with the light-house on Little Gull Island, about half a mile from my point of observation. There was no fog at the time these observations were made, but the siren's sounds were given regularly that their variations of audibility might be studied in the surrounding region.

The echoes were received from the sails of several schooners which were standing in the offing with all sails set and close hauled by the wind. The vessels varied in distance from me and from the siren from half a mile to nearly 2 miles. The wind was light, there was perfect silence around me, and the echoes reached me with almost startling distinctness. In timbre, or quality, they were exact reproductions of the siren's sounds; and in duration and time interval they also agreed with them. I estimated the intensity of the echoes at from 1 to 3 in a scale of 10, the latter number representing the full intensity of the siren's sounds. The angles of incidence and reflection by which they reached me were from 20° to somewhat more than 40°.

Considering the intensity and distinctness of those echoes, their identity of timbre, time length, and time interval with those of the direct sounds of the siren, the distances from which they were reflected, and the broad angles of incidence and reflection by which they reached me, I was impressed with the belief that such echoes when heard within either pseudumbral or montumbral areas may be a source of danger to passing vessels. The following diagram will show how sail echoes of a fog signal may be a source of danger to a vessel traversing a montumbral area in a fog, and it also illustrates the character of montumbral areas as they have already been described. (Pl. XI.)

A represents an elevated island; B, a small island with light-house and fog signal; and C, a montumbral area, the seat of an acoustic shadow caused by the elevated island. D represents a schooner with all sails set and close hauled. E represents another vessel, within the montumbral area, where, of course, the direct sounds of the fog signal are inaudible. These sounds, however, reach the sails of the vessel at D, and are reflected to the vessel at E, as an echo. To persons on board the vessel at E, the sounds of the fog signal seem to come from the direction of D.

Sail echoes of a fog signal which are recovered beyond the distal boundary of a montumbral area may, perhaps, also be reflected back into it, but lateral reflections, such as are represented by the diagram, are probably more likely to occur.

It can not be denied that the permanent conditions necessary for the casting of an acoustic shadow of a fog signal's sounds across a navigable channel, or a usual track

of vessels, are not common, but such conditions do exist in connection with certain of the fog signals which have been established along our coasts. Neither can it be denied that the occurrence of such a combination of permanent and adventitious conditions for reflecting the sounds of a fog signal from the sails of vessels into a montumbral area, as is represented by the foregoing diagram, is likely to be rare. Still, there is an undeniable probability that such cases may occur at any time, and it is also undeniable that they may be attended with danger whenever they do occur.

If my assumption is correct that a pseudumbral area is one of inaudibility of only such sounds as are projected toward that side of it which faces the neighboring fog signal, it may legitimately be assumed that sail echoes of the fog signal's sounds may be projected into a montumbral area. That is, if a pseudumbral area should be a short one, sail echoes of the neighboring fog signal may be projected into it laterally, in the same manner that they are represented by the foregoing diagram as being projected into a montumbral area. Recovered sound of the fog signal, upon the distal side of the pseudumbral area, may also be echoed back into that area from the sails of vessels. Such echoes may enter a pseudumbral area from any point of the compass within a range of, perhaps, one-half the horizon. To persons on board a vessel traversing one of these areas during a fog those echoes might readily be mistaken for the direct sounds of the fog signal, and the true location of the latter would in every case be falsely indicated.

The conditions under which echoes occur are numberless, and their observation has from time immemorial been prominent among the practical duties of mariners. They habitually use echoes of permanent objects as aids and as warnings from danger when guiding their vessels in a fog or in darkness, and sail echoes of sound from their own vessels are always to them warnings of possible danger of collision.

C.—INFLUENCE OF OBSERVER'S SURROUNDINGS.

The audibility of a fog signal depends not only upon the instrument that generates the sound and the influences that affect its transmission to the region where it is observed, but also upon the position of the observer and the disturbing influences that affect his hearing. Too little attention is generally paid to these circumstances. For example, a light-keeper reported that he could hear the sound of a fog signal about 10 miles southwest of his own station much better in a wind from the northeast than in one from the southwest. On questioning him closer it appeared that with a southwest wind the surf at his station drowned all other sounds, whereas in a northeast wind the sea was calm and he himself was completely sheltered by the buildings at his station.

Another keeper had noticed the same phenomenon at his station; he could not hear the distant signal from the light-house, but could hear it at his boathouse farther back in quiet water.

As another instance, our own observers once noted that a signal was repeatedly heard much farther in running away from it than in approaching it. An analysis of the observations showed that in a former case the vessel was running with a strong wind and in the latter case against it.

It has often been observed that a fog signal can be heard better at the masthead than on the deck of a vessel. This may be due to several causes: where the sound ray is so tilted up as to make the signal inaudible on deck at less than 1,000 yards distance, it has been noted that the audibility perceptibly increased in going aloft. On the other hand, at a distance of several miles, the effect of a few feet in elevation is comparatively insignificant, whereas the observer at the masthead is farther removed from the splashing of the waves or the sound of the engine.

IV.—Observations on Audibility of Fog Signals.

TESTS OF FOG SIGNALS IN THE THIRD DISTRICT.

The light-house schooner *Clover* was employed for a week or two in the summer of 1893, in the First district, in making tests of the audibility of fog signals in connection with the steam tender *Myrtle*. She was then detached and sent to the Third district, and later in the season was placed under the orders of Mr. Johnson, the chief clerk of the Light-House Board, who, in company with Dr. White and Prof. Hazen, fitted out an expedition to make a cruise in the Third and Second districts, and examine the aberrations of sound in cooperation with the tenders belonging to these districts, so that several vessels might observe simultaneously. This is very important, especially in order to investigate the phenomenon of "ghosts" or silence near a signal and a perceptible sound beyond it at the same time.

The *Clover* took many very valuable observations on this trip, recording carefully all the attendant circumstances, and Mr. Johnson has kindly placed all his records at my disposal.

A series of maps has been prepared showing the intensity of sound observed along the course, the direction of the wind, etc. The account of his work is taken from papers which he read last winter before the Philosophical Society in Washington.

Mr. Johnson says:

"As to our tools: We had on the *Clover* an anemometer at the foremast head and another at the end of the jib boom. Both were connected by electric two-conductor cables with self-registering apparatus in the cabin. We had also a barograph which registered the pressure of the atmosphere, and we had a very delicate barometer by which to check the barograph. These had been lent to the expedition by the Weather Bureau and were under the charge of Prof. Hazen, who looked after our meteorology. In addition to these, the professor had brought his own sling pschycometer, an ingenious arrangement of wet and dry bulb thermometers, which he managed with great skill and clung to with much affection. The *Clover* had her own complement of thermometers, barometers, etc., in addition to what had come to us from the Weather Bureau. The balloon which the Secretary of the Treasury had asked the Secretary of Agriculture to permit the Weather Bureau to lend us, and which had been shipped to us, did not arrive. Had it come we might have had Prof. Hazen looking down upon us from a great height, and we should have had him at the end of a rope recording temperature, air currents, moisture, wind, and sound from 1,000 feet above, and at intervals of 25 feet till we landed him on our deck or in the water.

"Now as to the method used to determine the intensity of the sounds of the fog-signal we tested. This we did, on this cruise, by ear, and on the same scale and in the same way in which it was done in observations made in 1881 and 1885.

"Each of the party on the *Clover* used the scale of 10. It was understood that 10 was the sound of the highest intensity, and 0+ the lowest sound observable. We divided the scale, however, thus: 1; 1 plus; 1½; 2 minus; and then 2. The question of personal equation has arisen, but I have carefully avoided any comparison of the mode of hearing, or rather accuracy of hearing, between members of my party. My direction to each was to record 10 as the highest sound of the fog signal that could be heard on board of the vessel in which he was making observations. When they were as near as they could get the vessel to the source of sound, the distance was, as a rule, not more than one-fourth of a mile. The minimum sound was 0+. One-half of the sound between 0+ and 10 was considered as 5, and halfway between that and maximum was called 7½, and then we divided still finer between those points. In that way I think we got a practical solution of the question and are as nearly accurate as it is practicable for observers to be, that is, for practical, but not for scientific, purposes."

*Little Gull Island, Long Island Sound, New York,** *off New London* (Charts IV, V, and VI).—"In 1881, 1885, and 1893, several days at a time were spent about this station. In 1893 two, and for a short time three, vessels were simultaneously engaged. On these several occasions all kinds of weather was encountered except snowstorms. The conditions were never the same and the results were constantly different. At one time the signal, a siren, could be heard as well at its rear as in its front; during the three October days I spent there it could not be heard in its rear at all. The *Galatea* ran ashore in a calm fog in 1880 on the little islet right behind and within 500 yards of the fog signal which is situated on the islet, and did not hear the signal at all, though it was proved that the signal was heard at varying distances and directions, even to 16 miles away. Yet at times I heard it half that distance in its rear. I even heard it clearly at Gardiners Point light-house. Yet it was not heard at all, practically, in its rear during any of the three days I was cruising about in last October, by any of the three vessels. In 1881 and 1885 I heard it at New London, and even at Mystic, 16 miles away, and I have heard it in a fog in every direction, at least 10 miles away. During the three days we spent in cruising around it last October, we would practically lose the sound, even in the axis of the trumpet, within 5 miles, and within 3 miles at the sides. The meterological condition, as indicated by air pressure, wind pressure, etc., during those three days have been tabulated by Prof. Hazen from self-registering barometers, anemometers, and thermometers, and are accessible."

*Beavertail** (Chart VIII).—"This fog signal is on the point of that name which separates the East Passage from the West Passage, both leading from the Atlantic Ocean to Narragansett Bay. The open ocean lies to the south. The island on which Newport is situated is about a half mile to the east. The land on which the rival watering place called Narragansett Pier is located is about a mile to the west. Both shores have many and deep indentations. The great sound steamers go either to the eastward or westward, as they may be bound to Newport and Fall River or Providence and in the fog they are guided to a certain extent by the steam whistle which is the fog signal at Beavertail Point. One of these steamers, the *Rhode Island*, in attempting the West Passage on the night of November 6, 1880, ran ashore on Bonnet Point, about 1½ miles northwest from Beavertail. The fog was dense and there was little if any wind. The newspapers stated that the officers and several passengers swore that the fog signal at Beavertail was not sounding at the time. Subsequent investigation, made at the instance of the Light-House Board by Lieut. Commander Chadwick, U. S. Navy, showed that the fog signal *was* sounding, and that it was heard several miles away in several directions. In the summer of 1881, in a heavy fog, running from Narragansett Pier to Newport, I came near wrecking the steamer *Cactus* by steaming as near to Beavertail as possible, that I might find out for myself if the fog signal, which I could not hear, was really sounding. It was not until we were abreast of the fog signal that we heard of it at all, and then it burst suddenly on us as if it had just been started. We carried the sound clear to Newport, and lying there the next day, Sunday, in a fog, we heard it all day. In 1885, when I spent a day cruising round Beavertail, I heard it at points where I did not hear it in 1881; and I did not hear it in 1885 at points where I did hear it distinctly in 1881.

"Last October I spent a day in cruising round Beavertail. Prof. Hazen, Dr. White, and I were at different surrounding points on ship or shore, taking notes simultaneously, and the results were in most respects different from any I had got before. The day was bright and clear, and there was little wind. I should say, however, that close on to Bonnet Point the fog signal was not heard distinctly on either of the three times I was there. The configuration of the adjacent coasts measurably accounts for this, or rather it is easy to get up a good working hypothesis as to the

* For view of this station see List of Lights and Fog Signals.

cause of the destruction of the sound of the fog signal at Bonnet Point; but nothing is yet proved on the subject, except that the sound of Beavertail fog signal is often not heard at Bonnet Point, which is less than 2 miles away, and it is in plain sight."

*Boston light** (Charts IX, X, XXXIX, XL).—"This light is situated on Little Brewster Island, at the entrance of Boston Harbor, Mass. A light was erected there in 1715-'16, the first built within the present limits of the United States. The fog signal there is a siren of the first or largest and best class. It has a pure musical tone and can be heard farther and better, all other things being equal, than any other of which I have personal knowledge. In 1885 I was sent there to make observations as to the performance of a battery of fog signals temporarily assembled there, as to which there was to be a competitive contest, to determine which of the several was the best adapted to that position. The siren came out easily as best, and hence is there now. But another fact was established, and that was that none of the signals, neither the bell, nor the steam whistle, nor the Daboll trumpet, nor yet the siren, could be heard at all in certain spots near by, and between which and the signal there was no visible obstacle, and beyond which the signal could be readily and distinctly heard. The naval officers were with me while this trial, which lasted two days, was made. The results were formulated, tabulated, and duly recorded.

"Last fall, two days and a part of another were spent by sometimes one, sometimes two, and for a large part of the time, three vessels, in cruising off the fog signal and in taking note of the intensity of each blast of this fog signal, simultaneously, from different points."

The results of these observations will be found below, in connection with the others taken during the past year in the First and Second districts.

The extensive observations taken in the First and Second districts during the past year and reported below have, it is thought, established the principles upon which the audibility of fog signals depend well enough to explain satisfactorily the phenomena recorded by Mr. Johnson both at Little Gull Island and at Beavertail. If these phenomena are compared with those at the same stations described in Mr. Johnson's Modern Light-House Service (pp. 74-85) it will appear that they are precisely what should result from the position of the signals and the direction of the wind. The signal at Little Gull Island faces to the northeast, and its sound is obscured in the opposite direction.

The signal at Beavertail † is placed on the south point of the island and its sound is somewhat obscured by the buildings to the north. Accordingly, unless the sound should be refracted downward by a favoring wind or a peculiar distribution of temperature, it is not to be expected that the signal would be heard to the rear.

Mr. Johnson has kindly sent me the original reports of Commander Chadwick and others, giving the details of their observations at these stations.

The fact that sound may be obscured by obstacles immediately behind a signal and yet heard at a great distance in the same direction is a well-known phenomenon. It is noted above under the head of A, fourth. It has been clearly described also by Prof. Henry and others.

A comparison of the diagrams for Little Gull Island ‡ will show that the signal is heard better with the wind and in the direction in which the siren points.

When the *Rhode Island* ran ashore at Beavertail she *did* hear the signal when she passed it, and having taken her course gave herself no further concern about it. There is no evidence as to whether she heard it when she went aground or not. There was a heavy sea running at the time, and she was almost directly in rear of the signal. Commander Chadwick's report gives all the data required to account for the fluctuations of sound which he observed on the 16th November, 1880. (*See* Chart VIII.)

He says: "The morning was clear and cold with a bright sun, and consequently

* Pl. LXXI. † *See* List of Lights and Fog Signals. ‡ Charts II-VI.

with a nonhomogeneous atmosphere, as was evidenced by the mirage, which, however, gradually disappeared toward noon. I left the station at 11:15, with the wind moderate from the west; earlier in the day it had been from the northwest." His record shows that the sound diminished irregularly as he left the station sailing northwest to Bonnet Point. He lost it a moment before reaching there, but he heard it close to Bonnet Point as he "changed his course to run almost due south." This is the effect to be looked for behind the signal, and somewhat against variable winds of different temperatures.

"It could not be heard at all on the line between the wreck and Whale Rock." The sound must have been dead against the wind. "I was unable to go any farther south than the points I have indicated, as I had intended, on account of the wind freshening into a strong southwest breeze, with a heavy sea, in which it was difficult to handle the boat. I think it is evident, however, that the sound is very defective at points to the westward of the signal. I am told by all the steamboat men that they never fail to catch it to the southward; and in southerly or southeast winds it is very noticeable in Newport, 4½ nautical miles distant."

As he approached the signal the sound increased to 10, and diminished gradually until he was nearly up to Fort Adams. Just off the fort and under the lee it was again estimated at its full intensity. Some fluctuations would be expected in such an air as he describes.

It is not practicable to explain every detail, but in comparing the intensity while skirting along the shore in a sailboat with that under the lee of the fort the effect of the noise of the wind and waves on the observers' ears must be remembered. Possibly, too, the sound wave may have been tilted down in blowing over the fort.

The motion of the winds in striking the scarp wall of Fort Adams is very violent and erratic.

Soon after this a whistle was substituted for the trumpet.

On August 6, 1881,* in a dense fog, with a strong breeze from the west-southwest and a heavy chop sea, Mr. Johnson could not hear the signal at Beavertail against the wind until he came dangerously near, but *with* the wind he heard it all the way to Newport, where it was heard continuously. The records of the observations here in 1885 are not at hand.

On October 26, 1893, the results are especially satisfactory and conclusive, for the *Clover* then carefully explored the area to the west of the station. With a favoring wind from the east-northeast, the whistle was distinctly heard, with an estimated intensity of 3 and 4, where the trumpet had not been heard by Commander Chadwick with an adverse wind from the west and southwest in 1881.

TESTS OF FOG SIGNALS IN THE FIRST AND SECOND DISTRICTS.

The following is a summary of the principal tests:

Libby Islands, Maine: January 26, 1894, 10-inch whistle.

Petit Manan: November 19, 1893, 10-inch whistle, 1,000-pound bell, and *Myrtle's* 8-inch whistle.

Mount Desert Rock, Maine: November 21, 1893, third-class Daboll trumpet, and *Myrtle's* 8-inch whistle, and 1,000-pound bell.

Deer Island Thoroughfare, Maine: June 2, 1894, regular fog bell.

Goose Rocks, Maine: June 2, 1894, regular fog bell.

Matinicus Rock: September 27, 1893, 10-inch whistles, regular fog bell, *Myrtle's* 8-inch whistle.

Whitehead, Maine: September 8 and 9, 1893, 10-inch whistles, 960-pound bell, and *Myrtle's* 8-inch whistle; September 28, 1893, 10-inch whistle, 1,040-pound bell, and *Myrtle's* 8-inch whistle; June 13, 19, and 21, 1893, 10-inch whistle.

Owls Head, Maine: September 7 and 8, 1893, regular 1,000-pound bell, 960-pound bell, and *Myrtle's* 8-inch whistle; June 13 and 14, 1894, regular 1,000-pound bell.

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*Modern Light-House Service, p. 76.

Manana Island, Maine: June 21, 1894, first-class Daboll trumpet.

Cuckolds, Maine: November 16, 1893, and June 21, 1894, third-class Daboll trumpet.

Seguin, Maine: September 14, 15, and 17, 1893, 10-inch whistle, 960-pound bell, and *Myrtle's* 8-inch whistle; June 22, 1894, 10-inch whistle.

Halfway Rock, Maine: June 12, 1894, regular fog bell.

Cape Elizabeth, Maine: September 11 and 12, 1893, second-class siren, 12-inch whistle, 960-pound bell, and *Myrtle's* 8-inch whistle; September 25 and 26, 1893, second-class siren and 12-inch whistle.

Portland Head, Maine: September 4, 1893, second-class Daboll trumpet and 960-pound bell.

Boon Island, Maine: September 23, 1893, regular fog bell.

Whaleback, New Hampshire: September 23, 1893, third-class Daboll trumpet, 1,000-pound bell, and *Myrtle's* 8-inch whistle.

Cape Ann, Massachusetts: November 14, 1893, and April 5, 6, and 7, 1894, 10-inch whistles.

Eastern Point, Massachusetts: May 4 and 5, 1894, 2,000-pound bell.

Baker Island, Massachusetts: September 22, 1893, regular 1,000-pound bell.

Minots Ledge, Massachusetts: May 8, 9, 10, 11, and 12, 1894, regular 1,000-pound bell and experimental 1,000-pound bell.

Boston Light, Massachusetts: October 30 and 31, 1893, first-class siren; January 23, 1894, 4,000-pound bell and 1,000-pound bell; January 31, 1894, first-class siren, 4,000-pound bell, and 1,000-pound bell; February 7, 1894, first-class siren (air), and first-class siren (steam), large Daboll trumpet, third-class Daboll trumpet, 10-inch whistle, 4,000 and 1,000 pound bells; February 28, 1894, first-class siren (steam), first-class siren (air), 10-inch and 8-inch whistles, 4,000 and 1,000 pound bells; March 22, 1894, 4,000-pound bell, third-class Daboll trumpet with 50-foot wooden extension; March 24, 1894, 4,000-pound bell, 1,000-pound bell in midstream and on scow; March 29, 1894, first-class siren (steam), first-class siren (air), 10-inch whistle, 8-inch whistle, 4,000-pound bell, cannon; April 24, 25, 26, 27, and 28, 1894, 4,000-pound bell, third-class Daboll trumpet with extension; May 11, 1894, 4,000-pound bell, third-class Daboll trumpet and 50-foot extension.

Race Point, Massachusetts: November 10 and 11, 1893, 10-inch and 12-inch whistles.

*Steamer Myrtle.**—The steamer *Myrtle* has been fitted up expressly for engineering work. The chart room is so arranged that the maps can be spread out on a revolving table and kept orientated while the steamer is moving. The windows on every side afford an unobstructed view. The meteorological instruments are set up on the deck above, or immediately behind, this room.

In running from the signal most of the observations have been taken from the vicinity of the chart room, and in approaching signals, from the pilot house, and care has been taken to select a point of observation where the sound would be unobstructed.

The usual practice has been to run a little faster than half speed for four minutes and then to stop one minute and listen to the signals. Sometimes it has been necessary to stop longer. In the report of observations it is to be inferred that the steamer has stopped to observe in every case in which it is not specified to the contrary.

The velocity of the wind has been measured by the anemometer and corrected for the motion of the vessel.

The scale used for estimating intensities.—While no attempt has been made to judge of the intensity of a sound with absolute accuracy, the impression of the intensities of signals, and of the same signal from different points of observation, and under different conditions of wind and weather, has been carefully recorded.

For uniformity in the record, a standard scale of numbers has been adopted, in which zero denotes the absolute inaudibility of a signal, and 100 its full power at a distance of 1,000 yards, with no intervening objects and under favorable conditions.

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* *See* Pl. LXXIII.

Where signals have been compared, the observer has in all cases let 100 represent the full intensity of the most powerful one. The number 10 has been chosen to denote the least sound of a signal which would be unmistakable, supposing the observer had come suddenly upon it, and had not his ear and mind tuned to perceive this particular pitch.

The varying intensities of these "almost inaudible" hums constitute that portion of the adopted scale ranging from 1 to 10.

The estimation of an impression of sound necessarily involves a personal function, to eliminate which sound-boxes producing a sound of standard intensity have been made and taken into the field of observation, where they have served as guides. The most efficient of these is a black walnut box, some 4 by 3 by 2 inches in dimensions, provided with a sliding cover and covered with thick felt. The sound is produced by means of a jews-harp fastened above a small resounding cavity, and sounded by a wooden arm which can be rotated by means of a key. It sounds very much like a fog bell. By means of this it was found that the intensities in the adopted scale were inversely as the distance from the signal.

Other boxes were provided with reeds to imitate trumpets, sirens, and whistles, and all were so prepared that the sound could be softened more or less by sliding the cover.

Then by adjusting the pitch and removing the box to the proper distance a sound was produced that so closely resembled that of the signal both in quality, pitch, and intensity that it was impossible to distinguish the signal from the imitation.

The sounds from these boxes could be reproduced or recorded, and it is proposed in the laboratory to measure their intensity and quality. The boxes afford a means of measuring sound by direct comparison similar to the measurement of light by the photometer.

The same observers have continued throughout the tests, and as they are men of some musical ability they have become quite expert in the work and their estimates practically agree.

Small balloons.—For wind observations small balloons have been utilized. Some are of rubber, inflated with hydrogen gas which is generated on board the vessel or at the station. These measure from 9 to 13 inches in diameter. Others are of colored tissue paper and raised by hot air from a burning composition attached. They measure from 4 to 6 feet in height and 3 to 4 feet in diameter.

A balloon of light, oiled cotton, 12 feet high and 8 feet in diameter, inflated with hydrogen gas, is kept at Boston light, but it is only useful in comparatively calm weather when kites can not be raised. This balloon is intended to carry self-registering instruments.

These small balloons have been kept constantly on hand to aid in the study of the currents of air or variations in the direction of the wind above and below. Whenever practicable, especially if anything unusual has been noticed, they have been released and their course carefully located to determine what effect the peculiarities in the upper strata of atmosphere were having on the sound.

In general, as was expected, the condition of wind has been normal, i. e., the direction has been constant, or nearly so, as we pass from one horizontal layer into another, while the velocity has sometimes increased perceptibly. This, we are certain, can be said to be the general condition of the air currents in the vicinity of shore stations. As most of the balloons released show simply these conditions, there is no need of describing in detail the path outlined in these cases, simply remarking that throughout the tests the wind directions have been determined in this way, as being more free from influences than vanes, flags, etc., on the boat or on shore.

The first unusual path described was that of No. 1, released at 9:35 a. m., September 12, 1893, off Cape Elizabeth, Maine. This balloon sailed off to the southwest as it left the *Myrtle* and began at once to veer to the right, and describing a semicircle went straight away to the northeast and was lost to view.

No. 2, released almost immediately, sailed directly west until lost to view.

No. 3, soon after, went southwest at first, but soon found a current of air in an opposite direction and began to circle toward the north as it disappeared.

No. 4 was still more variable. It started westward about 11:30 a, m., then circled to the northwest, then made a reverse curve through west into south, in which direction it passed from view.

At 11:30 a. m. the balloons went directly northwest until lost to sight. Before this time the wind had been northeast, and after the peculiar changes shown by the balloons, it was southeast.

From September 12 until November 21 no freaks in air currents were noticed, although during this time some interesting cases of sound disappearance had been noted. On November 21, at Mount Desert Rock, Maine, a balloon was released in the midst of an evident change of wind, as indicated by the motion of the clouds, and followed a westerly direction as it rose, then encountered a southwesterly wind and started suddenly to the northeast, continuing on this line until lost. A balloon released soon after followed a southwest wind throughout its course.

The next observation of change in direction between lower and upper currents came on January 23, 1894, at Boston light-station, Massachusetts, where Mr. Adams made a series of observations on the air currents in the vicinity of the island to see what effect the contour of land and the buildings might have on the wind as it passed the signal. Stations were established from which the balloons were located at intervals of 10 seconds. The air was cloudy, wind light, from the east; thermometer, 38° F.; barometer, 30.24.

From 12 to 12:30 p. m. it was a shifting wind, and the directions above and below were decidedly different. The balloons started westerly, rising rapidly, and after about one minute turned suddenly, and, still rising, sailed rapidly to the southeast, and so continued.

These balloons, taken together, showed clearly that the wind had changed above as the first was released, and the change descended during the half hour until the last balloon took its final direction soon after leaving the ground.

The balloons in passing the tower all circled around it rapidly and then resumed their original line of flight.

On February 7 and March 16 further observations were made at Boston light-station, but no new phenomena were noticed. On both days the wind was more constant than on January 23, and no opportunity was had for the observation then made.

Balloons were released in pairs, one above the other—not connected—and the upper went the faster, except in passing over buildings and similar obstructions, when the lower would start up suddenly in the eddies formed there.

On May 8, 9, and 10 balloons released from a launch to windward of the tower at Minots Ledge were observed from the launch and from the tower as they passed. They were released in pairs, care being taken in the selection that one should rise higher than the other and thus show the relative velocities of the upper and lower strata of the air about the tower. To accomplish this the observers were placed on the line of the direction of the wind, and the second balloon was released when the first passed directly above it.

Kites were made of the ordinary pattern, but did not give good results.

The recent experiments of Prof. Eddy and Mr. Clayton with Malay kites, at Blue Hill, give good promise of success. Mr. Wallace and Mr. Bradley were present at these experiments and report that self-registering instruments can be held at very great elevations.

On the charts illustrating these observations the direction of the wind is indicated by arrows and the Roman numerals written across them show the velocity in nautical miles per hour. The velocity was determined by anemometer on the steamer, reduced for her change of position.

The intensity of sound along the course is shown by the width of the line, in the manner first employed by M. Allard.

The time of day, in hours and minutes, is noted in Arabic figures along the course.

The compass bearings are magnetic and distances given in nautical miles.

A synopsis of the observation is appended to the report.

Lubec Channel light-station, Maine.—The fog signal is a bell struck by a Stevens machine every 10 seconds. The bell is hung from an extension of the veranda roof and overhangs the water. It faces SE.

The keeper says that in a S. or SW. wind vessels often hear the signal near Liberty Point and lose it after passing West Quoddy Head. These headlands form the entrance to Quoddy Roads and the sound is unobstructed in the space between them, but cut off on either side.

The keeper also says that in S. or SW. winds the bell is heard distinctly in the farther part of Lubec and sometimes in Eastport, about 4½ miles to the north. With the wind fresh from the NW. it can not be heard at Lubec, but as fogs seldom occur with these winds it is less important.

That in a NE. wind it can be heard distinctly in all directions, and best of all in a NE. snowstorm.

Little River light-station, Maine.—The fog signal is a bell struck by a Stevens machine every 30 seconds.

The keeper says that in a S. wind the bell can not be heard two ship lengths, and that the Libby Islands whistle, 7¼ miles to the westerly, is generally heard at Little River under almost any conditions of weather except a continued fresh or heavy S. wind, when it is not heard. The keeper does not think this is wholly due to the surf. He says that with a SSW. or NW. wind it can usually be heard plainly at Little River light.

The keeper also says that the Machias Seal Island whistle, 8¼ miles south, is best heard in a NE. snowstorm, and is heard plainly in any NE. or N. wind. He says it is not heard at Little River light-station with SW., NW., or W. winds.

Avery Rock light-station, Maine.—The fog signal is a bell struck by a Stevens machine every 11 seconds. It is hung from the SE. corner of a pyramidal bell tower.

The keeper says that this bell can be heard in all directions in an E. or a NE. wind. A SE. wind makes a surf that kills the sound of the bell. S. and SW. winds are also bad if strong.

*Libby Islands, light-station, Maine.**—The fog signal is a 10-inch steam whistle at the S. point of the island, and faces SE.

The keeper of Little River says it is generally heard at Little River light, 7¼ miles to the NE., except in a continued fresh or heavy S. wind, when it is not heard; that with a SW., W., or NW. wind it can usually be heard plainly at Little River.

The keeper of Moose Peak light, 10 miles SW. of Libby Islands, says the whistle can be heard in all winds except a SE. gale. The keeper of Nash Island light, 20 miles W. by S. from the Libby Islands light, says the whistle is heard best in an E or NE. wind, but not in a S. wind, because of the surf.

The signal used 109 pounds of coal per hour of running during the year ending June 30, 1893.

Libby Islands, Maine, June, 1892.—Maj. Livermore, Mr. R. Luther, and Mr. S. V. Poor observed a peculiar reflection in June, 1892, at this station. Coming down Machias Bay the whistle was heard in altogether a different direction from what seemed natural, while at times it was not heard at all. On investigation it was found that the direct sound was not heard, but an echo from the north end of the island. The direct sound was obscured by buildings, while the reflected sound was unobstructed.

Libby Islands, Maine, January 26, 1894 (*see* Chart XI).—The wind was ENE., about 10 knots. It was a clear morning, but with considerable vapor in the atmosphere.

*Pl. LIV.

Maj. Livermore and Mr. Luther went to Libby Islands to test the change of characteristic in the whistle at this station.

Leaving the island about 8:40 a. m. the *Lilac* ran NE. and up the bay and around the eastern end of the island, then back on the S. side and westward to Bar Harbor. When abreast of High Head, on the north side of the island, the *Lilac* seemed to enter a sound shadow into which the whistle was unable to penetrate. Continuing around the end of the islands the station was soon lost to view behind High Head. The wind was still ENE. and had freshened to 12 or 15 knots. It was very cold, the thermometer reading 7°.

The whistle was not heard on the course around the NE. end of Libby Islands until it became visible on the S. side, when it was again distinctly heard. From this position until the station was again abreast the intensity increased regularly up to its full power.

As the steamer proceeded to Moose Peak the intensity decreased regularly and was lost about 8 miles WSW. of Libby Islands.

*Petit Manan light-station, Maine.**—The fog signal is a 10-inch steam whistle. To the west it is partially obstructed by buildings.

The keeper at Moose Peak light says that in a light NE. wind he always hears Petit Manan whistle. This is 20 miles against the wind. That in a heavy NE. wind it can not be heard; that just before a NE. snowstorm it is very plain, that it is not heard in a W. wind.

The keeper at Nash Island light, 8 miles NNE. of Petit Manan, says it is easily heard there in a NE. or E. wind; that it is not heard generally in a strong S. or SW. wind, on account of the surf, and sometimes not heard in a SE. wind.

At Narraguagus light, 8 miles N. of Petit Manan, the keeper says it can not be heard in a SW. wind if there is much surf, but it can be heard very plainly in a N. or E. wind.

The signal used 72 pounds of coal per hour while running during the year ending June 30, 1893.

Petit Manan, Maine, June 2, 1893.—Wind NE., 10 knots. Bell A was operated on the *Myrtle* with a force of about 200 foot pounds. It was distinctly heard when 4 miles to the north and east, the *Myrtle* being at that time broadside on, with a reflector behind the bell. The bell was heard as well below as from the top of the tower, and better from before the buildings than from the open.

Petit Manan light-station, Maine, November 19, 1893—(*see* Chart XII).—At the beginning of this day's test the wind was blowing W. by N. with a velocity of 2 knots an hour, veering continually, until at the conclusion of the day's observation it had hauled to N. by E., rate 2.5 knots. This veering brought the wind approximately across the sound during this test. Barometer, 30; thermometer, 37° to 40° F. The sea was quite smooth, wave heights about 2 inches; sky clear, with very few clouds visible.

After landing materials at Narraguagus light, about noon, November 19, the *Myrtle* left for Petit Manan light to test the whistle at this station. It was already in operation.

The 10-inch whistle, used regularly as a fog signal, was sounded and observed by Mr. Wallace and Mr. Griswold from the *Myrtle*, while bell B was operated by hand and struck a blow of about 150 foot pounds on the *Myrtle*. The bell and whistle were observed at Petit Manan by Seaman Gunderson. On this test all the observations were made while the *Myrtle* was running under full speed.

Leaving Narraguagus light the whistle was heard for an instant at a distance of 4 miles to the NE. of the station. It was again picked up at a distance of 3 miles, and carried to the light.

Leaving Petit Manan the *Myrtle* carried the sound of the 10-inch steam whistle 5¼ miles to the NE. by E., and the *Myrtle's* whistle was heard 6 miles from Petit

* Pls. LV, LVI.

Manan. Returning, the Petit Manan whistle was heard 5 miles ENE. of the station, and the *Myrtle's* bell and whistle, 3¼ miles.

To the eastward, Petit Manan 5 miles, *Myrtle* 3¾ miles; ESE., Petit Manan 4 miles, *Myrtle* 4 miles, although a few blasts of the latter were audible at 5¾ miles.

Bell B was generally about equal to the *Myrtle's* whistle. The average pressure used on the Petit Manan whistle was 50 pounds, and that on the *Myrtle's* whistle about 35 pounds.

Petit Manan light-station, Maine, November 20, 1893 (*see* Chart XII).—The temperature was from 33° to 36° F; sea rough, wave heights about 1 foot; sky one-third clear, two-thirds cirrus and cumulus clouds; barometer, 29.87; wind generally NNE., about 19 knots.

The *Myrtle* started SE. and completed the circuit begun on the preceding day, the signals used being the same. The observations were made while running under full speed.

After sending up some balloons, which went directly SSW., exhibiting no effects of countercurrents, the *Myrtle* ran SE.

The 10-inch whistle was heard 3¼ miles, the *Myrtle's* whistle 3 miles, and bell B 3 miles. On losing the sound of Petit Manan signal the *Myrtle* ran SW., and on this course, while the whistle above mentioned was inaudible, bell B and *Myrtle's* whistle was so plainly heard at the light-station as to be recorded at one-half their full intensity. They were plainly heard 3¾ miles in an opposite direction to that in which the Petit Manan was heard 2¼ miles, although a 19-mile wind favored the latter. As the observers noted intensity of the Petit Manan whistle while the *Myrtle* was running, it was much more quiet at the light, and no comparison can be made between the signals.

Running S., by the whistling buoy, the *Myrtle* passed the spot in which the whistle can not generally be heard, and heard it to a distance of nearly 5 miles, with the wind. The *Myrtle's* bell was lost at 1¼ miles, and the whistle at 2¼ miles, against the wind.

Running NNE. for the light a peculiarity was noticed. The Petit Manan whistle was heard—one blast at 3¾ and one at 2½ miles—then lost as the *Myrtle* approached the station. It was not again heard until 1¼ miles from the light. This was probably caused by sudden changes in the velocity—perhaps even in the direction of the wind at the time, for the *Myrtle's* whistle was heard at the light during the periods of silence of the Petit Manan whistle. Its range was about 3 miles against the wind. The striking gear was out of order, and bell B was discontinued.

Running SW. the 10-inch whistle was lost at 2¼ miles, and the *Myrtle's* whistle was heard 2¼ miles, against the wind.

Returning ENE. the 10-inch whistle was obscured by the buildings and was picked up at 1¼ miles, although one blast was heard at 2 miles.

The course west of the light was then run, Petit Manan whistle being heard but 2¼ miles, while the *Myrtle's* whistle was plainly heard 3¾ miles, the intensity being estimated at 60. In this direction the whistle at the station was hidden from sight by the buildings, and at too great a disadvantage to allow of any comparison.

During this test the Petit Manan whistle did fairly well, although its audibility greatly varied. Its silence SSW. of the station and great range in a direction due south are accounted for by the changes in the velocity of the wind. To the E. and SE., where needed, the whistle is efficient, but from NW. to SW. its sound is greatly influenced by the buildings at the station.

It will be noted that south of the station, while the *Myrtle* was running south, the sound was heard much farther than while she was returning. This was mainly due to the fact that in running with the wind the point of observation was comparatively quiet, whereas in returning at full speed against the wind the noise of the wind and waves was so great as to drown any but the most powerful sound.

Mount Desert Rock light-station, Maine.[*]—The fog signal is a third-class Daboll trumpet, which points SW. from the lantern deck of the light tower.

The surrounding objects are shown in the illustrations.

The signal used 10 pounds of coal per hour of running during the year ending June 30, 1893.

Mount Desert Rock light-station, Maine, November 21, 1893 (*see* Chart XLII).—It was a cloudy, cold, day, changing to a slight flurry of snow and then clearing, with a few patches of cirrus clouds in the east and northeast. The sea was comparatively smooth at first, changing to a slight chop as the snow ceased. The wind freshened at this time, increasing from 6 to 17 knots. The wave heights increased from 1 inch to 1 foot. The barometer fell from 30.20 to 30.09. The thermometer varied from 40° F. to 43° F. The air felt cold and damp, and during the day the wind was in every quarter.

The *Myrtle* left Bar Harbor at 6 a. m. for Mount Desert Rock light-station. The regular third-class Daboll trumpet, operated by a caloric engine, was observed from the *Myrtle*, while the *Myrtle's* 8-inch whistle and bell B, operated on the starboard deck forward, were observed from the rock. The trumpet points SW. and the influence of the buildings is comparatively slight. The test began at 9:50 a. m. The observations of this day were made while the *Myrtle* was running at full speed.

The *Myrtle* started due west, running into a wind of 7.3 miles, and the trumpet was lost at 1½ miles. Returning on an ENE. course it was picked up at less than ¾ of a mile distance, although the 8-inch whistle on the *Myrtle* was heard at 3¾ miles.

The bell B began sounding at a distance of 2 miles, and was plainly heard from the light. Balloons sent up about a mile WSW. of the station described a peculiar path. They started directly NE., and on reaching an elevation of about 100 feet veered and went west. Wind velocity, 9 knots an hour.

The *Myrtle* then ran SW. and carried the sound of the trumpet 1½ miles in its axis. The *Myrtle's* whistle and bell B were heard at 3½ miles on this course and were about equal in intensity. Returning to the light, the *Myrtle's* whistle was heard at 3¾ miles and bell B at 3 miles, while the fog signal was picked up at 1 mile. After hearing a few blasts it suddenly ceased on account of a broken valve.

At 12:15 p. m. the apparatus was again started. The *Myrtle* ran S. and carried the signal 1¾ miles against a wind of 6.4 miles an hour. The *Myrtle's* bell was plainly heard at 2¾ miles. Returning over a NNW. course the 8-inch whistle was plainly heard at 2¾ miles with the wind, and the trumpet was first heard at ¾ mile against the 6½-knot breeze. Bell B was out of working order; it could not be regularly rung because the Kane kerosene engine, as then set up, was not powerful enough to operate it. After experimenting with it, it was rung by man power the remainder of the day with a force of about 150 foot pounds.

On the next course, running SE., it began to snow lightly, and the wind shifted from SSE. around through west into NNE. The signal was heard ⅝ of a mile, then was lost ½ mile, then heard ½ mile, lost ½ mile, heard ½ mile, and finally lost at 1½ miles distance. During all this time the *Myrtle's* whistle had been heard on shore to a distance of 1¾ miles without intermission.

Returning WNW. it was heard but 1½ miles, while the trumpet was barely heard at ½ mile, then lost for a moment, and finally regained at ½ mile from the station.

The *Myrtle* ran due east, returning SW. by S. The trumpet was heard continuously for 1½ miles going and ⅝ of a mile returning. Wind NW., 9 knots an hour. The *Myrtle's* whistle was heard 2½ miles going out and 1¾ miles returning. The wind was now SSW. ½ W., 17 knots an hour.

The *Myrtle* then ran NE. by N., returning due S. to the light. The trumpet was heard 1½ miles with the wind and the whistle 2½ miles against the wind. Coming

[*] Pl. LVIII, LX.

back, the trumpet was heard less than ¾ of a mile. The whistle and bell were sounded at 1 mile distance and estimated at 50 and 60, respectively.

Next course, NNW. going, and SE. returning. The trumpet was heard 1¾ miles going and 1 mile returning, bell and whistle 1¾ miles, after which no more observations were made. On the final course, WNW., wind W. by S., 16.4 knots, the trumpet was carried 1¾ miles and picked up ¾ of a mile on the return. The plot shows the sound of the Daboll trumpet as observed from the *Myrtle*.

The test lasted from 9:50 a. m. to 4:50 p. m. It will be seen that the average range of the trumpet on leaving the station was 1¼ miles, and on approaching it a little more than ½ mile.

The silence and reappearance of sound to the SE. of the station are explained by the variations of the wind and the rapid changes in the atmosphere. These were made apparent by snow squalls while the *Myrtle* was running this course.

Green Mountain, Mount Desert, Me., September 30, 1893 (*see* Chart XIII).—Wind, NNE., 28 knots at top of Green Mountain. The air was chilly and the sky overcast.

A party, including Maj. Livermore, Mr. Luther, and Mr. Griswold, started for the summit of Green Mountain as the *Myrtle* started for Petit Manan light. The day's observations were as follows: The mountain party observed the *Myrtle's* 8-inch steam whistle, and also bell B, which was operated by a Kane engine, and afterwards by hand, the force of blow being about 130 foot pounds by machinery and about 150 foot pounds by hand.

The sounds of the whistle and bell came to the observers at the summit of the mountain across the wind, and they were both heard 7 miles, both going and coming. The distance was verified by the interval between the puff of steam and the arrival of the sound at the summit. The bell as then operated seemed to be about equal to the 8-inch whistle.

Bar Harbor, Mount Desert, Me., November 18, 1893 (*see* Chart XXXI).—Wind, NW., 18 knots an hour; thermometer, 47.5° F.; barometer, 29.8; sea rough, wave heights about 1¼ feet; sky lowering, changing to black clouds and finally to heavy rain.

The *Myrtle* anchored in Bar Harbor at noon, and the afternoon was spent in experimental work on fog signals. The observers, Mr. Wallace and Mr. Griswold, rowed about the harbor, observing the intensity of bell B, which was set up on the starboard bow of the *Myrtle* and was rung by man power, about 150 foot pounds. The *Myrtle's* 8-inch whistle was also sounded at intervals of 2 minutes with a steam pressure of 30 pounds.

After exploring the western end of the harbor, and finding nothing of particular interest, the party went out by the eastern end of Bar Harbor and turned east, running behind Sheep Porcupine Island to the bell buoy. This island is quite steep and 180 feet high, and the party expected a great reduction in the intensity. Nothing of the sort occurred, however, and the clear tones of the bell rang out as though nothing intervened to cut it off. The 8-inch whistle was also heard very plainly. The *Myrtle* headed about W. so that the sound of the bell was strongest to the N. It was obstructed to the E. and SE. by the *Myrtle's* houses.

From the position inside the bell buoy nothing could be seen of the *Myrtle*. After watching this phenomenon for a short time, and deciding that it must be due to reflection from Bar and Round Porcupine islands, and from hills and buildings at Bar Harbor, the boat continued over the course shown on the chart, and generally heard the bell and whistle, although occasionally losing both. The range to the SE. was about a mile with the wind, while it was plainly heard at Burnt Porcupine Island, in which direction the signals were unobstructed, 1¼ miles across the wind.

Great Duck Island, Maine, May 31, 1894.—With a moderate SW. wind Maj. Livermore and Mr. Johnson heard the signal, a 10-inch steam whistle, 4 miles NNE. of the station.

Bear Island, Maine, June 1, 1894.—The signal, a bell struck by a Stevens machine, was heard 1¼ miles, with a SW. wind blowing two points in favor of the signal.

*Deer Island Thoroughfare light-station, Maine.**—The fog signal is a bell struck by a Stevens machine a double blow every 15 seconds. It is hung on the north side of a bell house, so that the sound is obstructed to the south by the bell house and the land.

Deer Island Thoroughfare, Maine, June 2, 1894 (*see* Chart XXXVIII).—Wind, SSW., 2 knots; thermometer, 68°; barometer, 29.21. The *Myrtle*, with Maj. Livermore as observer, traced the limit of audibility of the signal, a bell struck by a Stevens machine, finding it to vary regularly from one-fourth mile dead to windward to 3¼ miles at about two points from the leeward. The effect of the wind was materially increased by the position of the bell, which was so mounted as to throw the sound nearly in the direction toward which the wind was then blowing.

Goose Rocks light-station, Maine.—The fog signal is a bell struck by a Stevens machine every 20 seconds. It overhangs the south side of the lantern deck, and is obstructed to the eastward by Stimpson Island.

Goose Rocks, Maine, June 2, 1894 (*see* Chart XXXVIII).—This fog bell was struck with a blow of about 9 foot pounds, as tested on this day. This is a heavy blow for a Stevens machine. Maj. Livermore found the limit of audibility at right angles to the 10-knot wind to be about 2 miles. To windward, wind SW., 10 knots, the signal was heard less than three-fourths of a mile, but was heard a mile when the wind fell to 5 knots. To leeward, blowing over islands covered with trees, it was heard 2 miles.

Matinicus Rock light-station, Maine.†—The fog signal is a 10-inch steam whistle, mounted above a brick fog-signal house SW. of the south tower. The sound is thus heard best on this side, except within the sound shadow caused by the rocky cliff directly before the whistle house.

It is said that with rain or snow and a light breeze from NE., E., or SE. this signal is often heard at Whitehead.

The keeper of Matinicus Rock says his attention has been called to peculiar disappearances of sound in connection with the signal. Notably in August, 1890, he sounded the whistle repeatedly to attract the attention of the assistant keeper, who was less than one-half mile offshore and in plain sight of the signal, but the sound was not heard by him. It had been foggy, with light, variable winds, but it had cleared at the time referred to and was calm. He adds:

"On another occasion I was in a boat 100 yards from the NE. point of the rock, when the fog lifted so that I could see the steam as it came from the whistle, but could hear no sound. I rowed the boat say 150 yards to the SE., got the sound, then back to my first position, whistle bearing SW., and lost it. I then rowed to the NW. about the same distance and got the sound again. Wind S., light, with a heavy mist or fine rain."

Fishermen have complained that in S. to SW. winds and a dense fog they have heard the whistle some 12 or 14 miles and carried it to within a mile of the station, then lost it until they were nearly in the surf and could see the steam.

The signal used 85 pounds of coal per hour running during the year ending June 30, 1893.

Matinicus Rock light-station, Maine, September 27, 1893.—The day was pleasant and a light breeze was blowing from the ENE.

The *Myrtle* left Matinicus Rock light at 4:35 p. m., and ran NNE., sounding bell B, which was struck a blow of 80 foot pounds. On the rock were Maj. Livermore, Mr. Luther, Mr. Griswold, and the keepers. They observed the signals from the tops of the towers and from the ground near the north tower.

Running NNE. the bell was screened by the *Myrtle's* houses and consequently could barely be heard, even when less than a mile away. At 1½ nautical miles the bell was not heard. Returning, it was heard 3 miles.

It was found that it made little if any difference in the intensity whether the *Myrtle's* signals were observed from the land at the foot of the tower, from the top of the tower, or from any part of the rock from which the *Myrtle* was visible.

*Pls. LVI-LVIII. †Pls. LX, LVII.

Balloons sent up on this day showed no abnormal conditions of wind, but was in nearly a uniform direction until lost to view.

Matinicus Rock, Maine, May 31, 1894.—Maj. Livermore, and Mr. Johnson, observers. With wind SW., the 10-inch steam whistle could not be heard beyond Wooden Ball Island, about 4½ miles to the NNE. The buildings at Matinicus Rock were in range as the sound was lost.

*Whitehead light-station, Maine.**—The fog signal is a 10-inch steam whistle, mounted above the signal house on the south point of land.

This signal has for some time been the subject of considerable comment on account of the silence at a short distance to windward and well within the limit of average audibility.

It has been more frequently noted with the wind S. to SW.

The Boston and Bangor Steamship Company run daily through Muscle Ridge Channel, and it is also used by nearly all the shipping running into Rockland, Bangor, or other ports on the Penobscot from the westward.

Many complaints have been made that the keeper was neglecting his duty by not starting the signal at the first coming of the fog. With S. to SW. winds, it is often heard at a distance of 4 or 5 miles and then lost on approaching the station from the SW.

Besides the 10-inch whistle, there is a 2,000-pound bell at this station rung by hand when the whistle is disabled. The pilots claim that this is much more easily located in a fog and generally prefer it to the whistle. By request, the keepers generally ring this bell in answer to signals even though the whistle is in operation.

The signal used 61 pounds of coal per hour when running during the year ending June 30, 1893.

Former tests.—An account of some of the former tests of the audibility of this signal will be found in Henry on Sound and in the reports of the Light-House Board from 1870 to 1878. Later observations are described in Johnson's Light-House Service, pp. 88, 89, and in Reports of Light-House Board. They have already been discussed in the present report, in connection with the controversy between Henry and Tyndall.

Whitehead, Me., September 8, 1893. (See Chart XIV.)—The wind was about 6 knots from the WNW., and the sea was running high.

At the close of the test at Owls Head on this day the *Myrtle* steamed to Whitehead to make observations on the 10-inch steam whistle at the station, and to notify the keeper of the test planned for the following day. At the first sound of the signal the *Myrtle* got under way from Whitehead, running SW. by W., the sound being still plainly heard at 3½ miles as she turned to run for the light. Running for Owls Head, it was first lost at Otter Island, 3½ miles across a 6-knot breeze. Nothing unusual was developed on this trip.

Whitehead, Me., September 9, 1893. (See Chart XV.)—The sky was clear blue with cirrus patches. The sea was quite smooth and the wind WSW., about 9 knots an hour. Barometer, 31.03; thermometer, 69° F.

The *Myrtle* steamed to Whitehead towing the *Clover*, and then began observations on the 10-inch whistle and on bell A, set up, as before, on the *Clover*, which was moored on the north side of the station. The bell was struck a blow of 178 foot pounds.

Left Owls Head 7 a. m. The observation party was the same as on the previous day. The whistle was distinctly heard as the tenders left Owls Head, and a few trials were made of a zinc ear trumpet for listening, but the wind produced vibrations in the trumpet which more than offset the advantage of collecting the sound rays.

At Ash Island the whistle was plainly heard 5 miles across a 10-knot breeze. From this point to Whitehead the sound generally increased regularly, although twice lost for a moment.

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* Pls: LII, LXII, LXIII.

Leaving the *Clover* at the wharf the *Myrtle* returned through Muscle Ridge Channel, carrying the sound of the bell to the Garden Island spindle, 2¼ miles NE. across the wind, and that of the whistle to a distance of 3¾ miles. Through Fisherman Island Passage the whistle was occasionally heard, though it was much too faint for use in navigation.

The next course lay through Two-Bush Channel, and thence to Tennant Harbor light. The whistle was heard plainly until at about 1 mile from Tennant Harbor light, when it was not heard over a space of three-fourths of a mile, and then again heard. The whistle was easily heard, except from within the sound shadows of the islands. The bell was heard but once, the distance being 2¼ miles, with a favoring wind of 9 knots. The sound was obscured by the land at the light-station and by the position of the *Clover*.

Afternoon: The wind was now southwesterly, about 15 knots, and a "ghost," or abnormal silence, was expected to the windward. During the afternoon, the *Clover* cruised to the south of the station, ringing bell A in the usual manner.

The *Myrtle*, with the same party as in the morning, steamed southwest 1 mile, then westerly, and lost all traces of the signal at less than 1 mile. Running for the station, the sound was first heard at three-fourths of a mile, and even then but faintly. The *Myrtle* next ran SW., heard the signal at 2 miles, then lost it. At 3¼ miles it was again heard, and was carried to 4 miles. The limit was reached off Mosquito Island, where a few blasts were heard. The wind was now 11 knots an hour, dead against the sound. The whistling buoy off Monhegan Island was plainly heard at this point, distance 10 miles, with the wind in favor of the signal. On the return to the station the whistle was picked up at 5 miles and carried to 2¼ miles, when it was lost, although the steam could be seen issuing from the signal. From here but one blast was heard, and that very faintly, until the *Myrtle* reached the bell buoy, three-fourths of a mile from the signal house, when it came out with great force, and was then heard to the station. The wind had continued in the SW. all the time, and was now blowing at the rate of 15 knots an hour.

During the afternoon, bell A on the *Clover* was heard generally at 2 miles, and at one time nearly 3 miles against the wind. It was also distinctly heard when the *Clover* and *Myrtle* were both within the silent area, when the *Myrtle* was within and the *Clover* without, and when the *Myrtle* was without and the *Clover* within, showing that sounds from other directions than that of the light-station had no difficulty in penetrating it.

Whitehead, Me., September 28, 1893 (*see* Chart XVI).—The sky was cloudy all day, and the air very damp and disagreeable, while showers came and went continuously. The sea was running about 1 foot high, the barometer was 30.13; the thermometer 49° at noon. Some small balloons sent up during the forenoon showed simply a NNE. wind, with no apparent variations in the upper currents. The rainfall averaged 0.008 inch an hour during the day.

The 10-inch steam whistle, regularly used as a fog signal, was run in the usual manner, with a pressure of about 45 pounds. The 2,000-pound bell, which replaces the whistle in case of a breakdown, was rung by hand as hard as possible.

On the *Myrtle* the 8-inch steam whistle was sounded occasionally, while bell B was struck regularly by the Shipman engine with a blow of 178 foot pounds.

The *Myrtle* carried as observers Maj. Livermore, Mr. Luther, Mr. Wallace, and Mr. Griswold. At the light-station Mr. Adams and a party of assistants observed the pressure on the boilers, rung the bell, and recorded the weather observations, besides noting the intensity of the *Myrtle's* signals.

The *Myrtle* left Owls Head about 7 o'clock, and first heard the whistle as she passed Otter Island, a distance of nearly 4 miles, against a 12-knot wind. It was carried down the channel until the distance from the whistle was 2¼ miles, when it was lost, and not again heard until the distance was ¾ mile. Leaving the shore party, the *Myrtle* returned to explore the "ghost," or abnormal silence, which had

been observed. The whistle was faintly heard at ½ mile and lost at ¾, remaining unheard as the *Myrtle* ran up the channel. * The sky had been lowering all the morning, and it began to rain at this point. The steamer was immediately headed for the light, and the whistle was plainly heard where before it had not been heard, and was now carried to the light, with the exception of a few minutes that the *Myrtle* was in Seal Harbor, where the sounds were cut off by the hills of the island.

The effect of rain upon the propagation of sound was confirmed by the observers at the station, who heard the *Myrtle's* signals while it was raining, but not before or after.

Afternoon: Dry-bulb thermometer, 49° to 49.9° F.; wet bulb, 48.6° to 49.7° F.; barometer, 30.13, the percentage of moisture at 3 o'clock being about 90 per cent. The balloons showed no evidences of countercurrents of wind.

The *Myrtle* started toward Owls Head about 12 o'clock, and reached it about 2, during which run the whistle was not heard over 1½ miles, although on the return it was heard for a moment at Ash Island, distant 4½ miles. Both these observations were against a wind of 17 knots and upward. Bell B was heard, though faintly, at 3¾ miles, with the strong favoring wind, while stray blasts of the *Myrtle's* whistle were heard 4½ and 6¾ miles. The presence of rain was at all times accompanied by an increase in the range of signals.

The last trip of the *Myrtle* during the day was to the southwest of the station, in which direction, with the wind in its favor, the Whitehead whistle was heard over the entire course, the greatest distance being 3¾ miles. The Whitehead bell was heard 2½ miles in the same direction. The *Myrtle's* whistle was plainly heard at 2 miles and faintly at 3½ miles, against the strong wind. Bell B was obscured by the *Myrtle's* houses until it was out of range, and was not heard on this course.

The results of the experiments at this station indicate that "ghosts" depend mainly on the wind.

Whitehead, Me., June 13, 1894.—Thermometer, 54° to 61°; barometer, 30.36; wind SE. about 3 knots. Sky clear blue, with stratus and cirro-stratus clouds about the entire horizon; sea smooth as glass.

The *Clover* left Whitehead for Owls Head on the morning of June 13, and the Whitehead whistle was observed by Mr. Wallace and Mr. Griswold. It was plainly heard to Ash Island tripod, 4½ miles NE. of the station, when the whistle was stopped, so that the range could not be determined.

Whitehead, Me., June 21, 1894 (*see* Chart XVII).—The *Clover* left Owls Head Bay at noon in tow of the *Myrtle*, and went down Muscle Ridge Channel to Whitehead light, observing the whistle at this station. There was a light fog as the tenders left the bay, which became very thick as they went down the channel, entirely obscuring objects at two boat lengths ahead. The sound increased in intensity until the *Clover* passed Ash Island tripod, after which for a short time it was somewhat reduced. The fog was still thick.

After leaving Garden Island spindle the intensity increased regularly until Whitehead station was reached. At this time the *Myrtle* left the *Clover*, the log was thrown out, and the *Clover* sailed toward Monhegan Island. Wind ESE., 3 knots, increasing to 6 knots near the limit of audibility of the whistle, and then dying out entirely as the whistle was lost, 10 miles SW. of the station. At 10½ miles the whistle was again heard for a half dozen blasts across a breeze of 2 knots. The position was located by the direction of sailing, the log reading, and the breaking of surf on Burnt Island, a short distance to starboard.

*Owls Head light-station, Maine.**—The fog signal is a 1,200-pound bell struck by a Stevens machine with a blow of about 8 foot pounds.

It is set up at the edge of a cliff and backed by the hill on which the light-house stands. Thus the sound is obstructed to the N. and NW. of the head, and is strongest to the SE., the direction the bell faces. The bell house also acts as a screen,

* Pls. LXIII. LXIV.

reflecting the sound to the SE. The position and surroundings of the bell are shown in the illustration. The elevation of the bell is 53 feet above mean sea level.

Owls Head, Maine, September 7, 1893 (*see* Chart XVIII).—Wind, SW. to S., 6 knots; sky, clear to the north and east, but mottled overhead; sea, choppy, running about a foot high; thermometer, 59° F.; barometer, 30.2.

The regular fog bell at this station, weight 1,200 pounds, was operated by the regular Stevens machine, at an elevation of 53 feet. It is situated at the edge of the bluff on the eastern point of the head, and is backed by a sloping hill of 40 feet, on which the light-house stands. The bell house also acts as a reflector, sending its sound to the southeast.

Bell A was operated by the Shipman kerosene engine on the forward deck of the *Clover*, the force of blow being 178 foot pounds. The engine used 18 pounds of water and six-tenths gallon of oil per hour. The *Clover* was anchored in the channel to the eastward of the fog bell.

The launch, with Maj. Livermore, Mr. E. P. Adams, Mr. J. H. Wallace, and Mr. M. M. Griswold as observers, after a preliminary trip to accustom the observers to the adopted scale, ran SE. from the head, carrying the Owls Head bell 2½ miles and bell A about 2¾ miles. Rain began to fall during the latter part of the course. The experimental bell was decidedly the stronger at all times. The launch was found to be unfit for observing fog signals, on account of a ringing in the stack which made it very hard to tell whether the bells were heard or not. The observations were continued on the *Myrtle*, which offered much better accommodations. Returning to the station, bell A was heard at 1¼ miles, and the Owls Head bell at three-fourths of a mile. The *Clover* had turned with the tide, so that she now presented the wrong side to the observers.

Afternoon trip: Wind, E. by S. to SSE.; raining steadily. Mr. Adams returned to Owls Head, the remainder of the party continuing the observations on the *Myrtle*. The *Myrtle* ran 2 miles to the NNE., and returned over the same line. The Owls Head bell was heard 1¾ miles going out, and 1 mile returning. The *Clover* had turned so that bell A faced the bluff and could not be heard to the NE. Running SE., wind SSE., the Owls Head bell was heard 1 mile going and 1¼ miles returning, the latter course being more free from the effect of the sound shadow cast by Munroe Island. Bell A was heard about 2 miles both going and coming. This was 30° against a 4-knot breeze. The next course was to the eastward, and the Owls Head bell was carried 3 miles through a heavy rain and haze. Bell A was heard at 3½ miles, as the *Myrtle* turned to run south. Both bells were heard at times on this course, but were soon cut off by the islands. In Fisherman Island Passage bell A was heard twice. A thick fog had now arisen.

Owls Head, Maine, September 8, 1893 (*see* Chart XIX).—Wind, NNW., from 16 to 25 knots an hour; thermometer, from 50° to 55° F.; barometer, 29.84; sky, cloudy; sea, choppy, the waves running about 3 feet high.

The same signals were tested as on the previous day, the *Clover* being again anchored about 100 yards to the east of the head. The *Myrtle's* observation party consisted of Maj. Livermore, Mr. Wallace, and Mr. Griswold.

In the morning the *Myrtle* ran NNW., against the wind, losing the sound of both signals at half a mile. At three-fourths of a mile the Owls Head bell was heard for an instant, then lost. On running E. by S., bell A was heard at a distance of 1 mile across the wind, then lost until the *Myrtle* was 2 miles SE. of the head, when both were heard, bell A being the louder. At 3 miles to the SE., behind Munroe Island, bell A was at times distinctly heard. Through Fisherman Island Passage and back to Owls Head, the Owls Head bell was not heard until the observers were within one-half mile of the head. The experimental bell A was occasionally heard at 2½ miles down the channel, and regularly under 1¼ miles.

The wind had diminished to 16 knots, still blowing from the NNW.

The next course was into the wind again, the Owls Head bell being lost at less

than one-fourth of a mile, owing to its peculiar position. Bell A was heard three-fourths of a mile due north of the *Clover* and on running west was generally heard over a mile to windward. On running for the head the observers were surprised at the utter failure of the Owls Head bell in this direction. It was silent until the *Myrtle* came within 300 yards of it, in the direction of the Shag Rock tripod. This silence was partly due to the bell house itself and partly to the hill on which the light is located acting as a reflector and sending the sound to the southeast.

Owls Head, Maine, June 13, 1894 (*see* Chart XX).—Sky, clear; thermometer, about 6–; barometer, 30.36; wind SE., 5 knots. While the *Clover* was landing materials at this station Mr. Wallace and Mr. Griswold went in the launch over the course of vessels from Rockland to Owls Head, and out by the end of Munroe Island. The sound of the Owls Head fog bell was carried three-fourths of a mile NW. and then to the end of Munroe Island, 1 mile SSE. of the station.

Owls Head, Maine, June 14, 1894 (test of the *Myrtle's* 8-inch whistle, Chart XX).—Sea, perfectly smooth, no wind whatever; sky, hazy, but with no defined clouds. Barometer fell from 30.50 to 30.36, and thermometer on deck varied from 64° to 6–.

The *Clover* was anchored five-eighths of a mile NW. of Owls Head, landing materials. The *Myrtle* was engaged in inspection in the vicinity, and it was arranged that she should sound her 8-inch whistle every half minute during the day, while Mr. Wallace and Mr. Griswold from the *Clover* should observe intensities, locate her by bearings and the interval between puff of steam and sound, and make weather observations.

The Owls Head bell was struck continuously during the day, to act as a standard in estimating the intensity of the whistle.

The *Myrtle* left the *Clover* about 9 a. m. and steamed to Camden, the whistle being heard until it stopped blowing as she passed behind Negro Island light, 6 miles to the NNE. After the *Myrtle* came out of Camden Harbor the whistle was again blown and heard. When she was 2¼ miles to the eastward the sound was very strong, apparently of its full power. The whistle was heard until the steamer passed out of sight beyond Hurricane Island, 4½ miles to the SE. of the *Clover*.

On her return trip the whistle was heard at the *Clover* before it came in view, about 5 miles to the SE. and carried until it stopped blowing, as the *Myrtle* entered Camden Harbor. From the top of Megunticook Mountain the *Myrtle's* whistle was heard 6 miles.

Owls Head, Maine, June 14, 1894, (*see* Chart XX).—Sea, calm; sky, clear and bright; the wind was southerly and fell from 6 knots to 3 knots on the course. After unloading materials at Owls Head the *Clover* sailed to Negro Island light-station, and on her way Mr. Wallace and Mr. Griswold observed the bell at Owls Head. The sound was carried 3¼ miles to the NNE. There were no unusual phenomena. The sound increased in intensity as the *Clover* left the sound shadow cast by Owls Head, and then decreased regularly until lost.

Vicinity of Owls Head, Maine, June 19, 1894.—Foggy, lifting and shutting in repeatedly. The *Clover* left Rockland Harbor at 7:30 a. m. and finally reached Mussel Ridge Channel, against wind and tide, and anchored in Owls Head Bay. Mr. Wallace and Mr. Griswold observed the Owls Head bell and the Whitehead whistle, both of which could generally be heard. It was found that the sound of the Whitehead whistle increased considerably when the fog shut in, and fell off when it lifted.

After anchoring at Owls Head Bay, 7¼ miles NE. of Whitehead light-station, it was still found that the audibility of the whistle, as well as Owls Head bell, increased when the fog shut in.

Manana Island fog signal, Maine.—The fog signal is a first-class Daboll trumpet on the west side of the island and points a little north of west. It is operated by a caloric engine, in the usual manner, at a pressure of about 5 pounds.

The sound is screened to the north and east by Manana Island and Monhegan Island and the buildings about it.

This signal is said to be sometimes heard at Seguin, 20 miles to the westward, when it is nearly calm. It is also said to be occasionally heard at Burnt Island, Boothbay Harbor, in a light wind.

The signal used 25 pounds of coal per hour of running time.

Manana Island, Maine, June 21, 1894 (*see* Chart XXII).—Thermometer ranged from 53° to 58° and the barometer from 30.17 to 30.34; wind, light and uncertain during the day, and frequently none at all. The *Clover*, sailing from Whitehead to Monhegan, picked up the sound of the Daboll trumpet at about the time Whitehead whistle was lost, and carried it, increasing regularly, to the island, with no peculiarities. This was in a heavy fog which hid everything from view at two boat lengths. As the *Clover* arrived at this station the fog cleared up and the trumpet was stopped.

By request the keeper continued the signal that the observers, Mr. Wallace and Mr. Griswold, might continue observations as the *Clover* sailed west. The trumpet was heard until 9:30 p. m., 6¾ miles from the station. There was at this time a light baffling wind, NE. and then SE., and Monhegan and Seguin lights were both visible.

The distance of audibility on the approach to Monhegan was about 6¼ miles in a NE. direction.

*Cuckolds fog signal, Maine.**—The signal is a third-class Daboll trumpet, facing E. by N. from the south end of the signal house. It is on the most easterly of the Cuckolds, at the western entrance to Boothbay Harbor. The keeper says his signal is heard at Damariscotta in a NE. wind, and especially in a NE. snowstorm.

The signal uses 13 pounds of coal per hour of running.

Cuckolds fog-signal station, Maine, November 16, 1893.—Wind, WNW., about 27 knots an hour; barometer, 29.64; thermometer, 39° F. Sky, clear blue, with cirrus clouds to the N. and NW; sea, rough, with a heavy swell.

The third-class Daboll trumpet regularly used at this station was sounded. The observers, Mr. Wallace and Mr. Griswold, heard it about 2¾ miles ENE. to Ram Island light, almost directly with the wind. The trumpet points in an E. by N. direction.

Cuckolds Island, Maine, June 21, 22, 1894 (*see* Chart XXIII).—The temperature while the signal was heard on the evening of June 21 was 56°; barometer, 30.25.

In a light wind, blowing NE. and then SE., on the night of June 21, while on the trip westward from Monhegan Island, the observers on the *Clover*, Mr. Wallace and Mr. Griswold, heard the fog signals at the Cuckolds, a Daboll trumpet, and carried it until it stopped blowing at 11 p. m. It was probably foggy at the Cuckolds while the signal was blowing, as lights in their vicinity were invisible, although the air was quite clear at the *Clover*, and Monhegan and Seguin lights could be seen. At 11 p. m. the signals stopped and the observers retired, leaving instructions to be called on deck should the fog close in again. The fog came at 3 a. m. on the 22d, and the Cuckolds' trumpet was heard for about an hour at a distance of about 8 miles southeast of the station.

Seguin light-station, Maine.†—The fog signal is a 10-inch steam whistle on the roof of a brick fog-signal house, about 250 feet south of the light-house, which is on the highest part of the island.

Seguin is a guide to the Kennebec River and a most important station. The tower, dwelling, and rocks north of the signal somewhat obscure the sound in this direction.

Near the station the sound is somewhat obstructed in all directions by the land of the island, which forms a sound shadow (*see* illustration).

It is said that this signal is plainly heard at the Cuckolds station, 6 miles NE. of Seguin, in a NE. wind; that in a SW. wind it is not heard except in a very light air;

* View of this station in List of Lights and Fog Signals.
† Pls. LXIV, LXVI.

that in an east wind it is not as plain and not every blast is heard: that in S[illegible] port, Seguin is not heard in a SW. wind but is plainly heard in a NE. wind.

This signal uses 90 pounds of coal per hour, when running.

Seguin light-station, Maine, September 14, 15, and 17, 1893.—On September 14, [illegible] the *Myrtle* left Portland for Seguin Island to land lumber, and also to test the 10-[illegible] whistles at this station and the bell at Pond Island light-station.

Bell A was operated on the forward deck of the *Myrtle* by the Shipman kero[illegible] engine with a blow of 178 foot pounds. Mr. Wallace and Mr. Griswold observed [illegible] intensities of the regular signals at Seguin and Pond Island. The Seguin kee[illegible] kept a record of the pressures, coal used, etc., but it was unfortunately lost in [illegible] mails. The pressure averaged about 50 pounds. The notes taken by the Pond Isl[illegible] keeper were received.

September 14, 1893 (see Chart XXIV).—Wind, SW. by S. to SSW., estimated 16 kn[illegible] thermometer, 61°; barometer, 30.20.

Two balloons sent up just before leaving the cove at Seguin started NE. by N., [illegible] two minutes later appeared to strike a countercurrent having a westerly direc[illegible] In falling they again went NE. by N.

On the way to Pond Island the Seguin whistle was plainly heard to the bell bu[illegible] distance 2 miles, when its intensity was suddenly diminished, and it was lost be[illegible] the *Myrtle* reached Pond Island. The *Myrtle* then returned to Seguin. Compl[illegible] having been made of the inaudibility of the signal to the SSW. of the station, [illegible] most attention was directed to this area.

The *Myrtle* ran S. by W., losing the sound at Mile Ledge buoy, less than 1 [illegible] distant. In the same direction the whistle was faintly heard at a distance of 1¼ [illegible] 2 miles respectively, while between these points it was silent, and then the wh[illegible] came out plainly at a distance of 2¾ miles, and was lost at 5¼ miles. The *Myrtle* [illegible] followed the limit of sound in a westerly direction, and then running NNE., p[illegible] again through alternations of silence and sound, though the variations were [illegible] marked as before.

September 15, 1893 (see Chart XXIV).—Wind, SE., estimated 18 knots; w[illegible] between 2½ and 3 feet high; thermometer, 61° F.; barometer, from 30.14 at 7:[illegible] 31.3 at 9:30 a. m. There was a heavy mist all morning and at the conclusion of [illegible] test it began to rain.

The observers began taking notes at 7:15 a. m., at which time the *Myrtle* was l[illegible] two-thirds of a mile W. by S. of Seguin. The whistle was inaudible at this p[illegible] although the steam was visible. The *Myrtle* stopped here five minutes, and [illegible] whistle was occasionally heard, although faintly. Had fog obscured the whist[illegible] is doubtful if it would have been noticed.

The *Myrtle* then ran E. by S., and when passing due south of the tower, *less* [illegible] *half a mile off*, the whistle could barely be heard. It was picked up 1¼ miles S[illegible] Seguin. Running SW. ¼ W. it was soon lost and remained unheard over a spa[illegible] about 3 miles. Suddenly a fog settled down, obscuring the Seguin light tower, [illegible] the *Myrtle* steamed back to the station. Within one-half mile of the station [illegible] whistle was unheard. It was finally lost about halfway to Pond Island light.

At 9:15 o'clock, as the *Myrtle* was passing the bell buoy, the bell A was crack[illegible]

September 17, 1893 (see Chart XXV).—The wind was SSW. and blowing a g[illegible] which accounts for the short range of the signals. It was at least 25 knots an h[illegible] in velocity. No countercurrents were shown by the balloons. The sky was q[illegible] clear, a few cirro stratus clouds being visible.

The *Myrtle* lay at Boothbay Harbor during September 16 on account of the st[illegible] started early on the following morning, and reached Seguin at 7:20. The wh[illegible] began to sound at 8:10 and the test began. The range was short this day, vary[illegible] from three-fourths of a mile to the SW. to a maximum of 1¾ miles N. by W. [illegible] WNW. from Seguin. No silent areas was found within the limits of audibility.

The following facts seem to be well established as a result of these tests:

(1) In a violent SW. wind the Seguin whistle can not be depended on by mariners beyond Mile Ledge Buoy on the south, Jackknife Ledge on the northwest, and Pond Island bar bell buoy and White Ledge on the north.

(2) A strong SW. wind cuts off and breaks up the sound of this signal to windward, but does not materially improve it to leeward.

The Pond Island keeper says that with any strong wind the Seguin whistle is but faintly heard at Pond Island. The Pond Island bell is occasionally heard at Seguin in a dead calm. During the foregoing tests this bell was never heard over half a mile, and was usually lost at the Pond Island bar bell buoy.

The Pond Island keeper heard the *Myrtle's* whistle from a point one-half mile beyond Mile Ledge buoy, or 3½ miles from Pond Island, and bell A was heard about 1½ miles with the wind. This was on the 14th. On the 15th the Pond Island keeper heard the *Myrtle's* bell 2½ miles, and the whistle 3½ miles in the same direction. This was at a time when the Seguin whistle was plainly heard. On the 17th he heard the *Myrtle's* whistle calling up the Seguin whistle, the *Myrtle* being 2½ miles from Pond Island light.

As the *Myrtle's* is an 8-inch, and the Seguin's are 10-inch whistles, this result was probably due to their surroundings.

Countercurrents were noticed on the 14th, while on the 15th and 17th no balloons could be launched because of the wind and rough sea.

Seguin, May 30, 1894.—Wind ESE. about 10 knots, and rain fell at intervals. Maj. Livermore and Mr. A. B. Johnson, chief clerk of the Light-House Board, observers, heard the 10-inch steam whistle only 1½ miles against the wind.

Seguin Island, Maine, June 22, 1894 (*see* Chart XXVI).—Thermometer ranged from 39 to 69°; barometer from 30.34 to 30.24; almost no wind. At 10 there was a light wind from the NNE.

On the trip westward from Monhegan Island the whistle at Seguin was picked up at about 3:20 a. m. At this time the light at that station had just become obscured by the fog, and a light, baffling wind was blowing, first from the NE., then from the SE. Soon after this the wind died out entirely, and until about 10 a. m. the whistle was heard plainly. Then the fog lifted, and the whistle stopped blowing. It was heard 7½ miles W. by S. of the station just before it stopped.

*Halfway Rock light-station, Maine.**—The signal is a bell struck by a Stevens machine and surrounded by a framework and slats, which perhaps obstruct the sound to some extent.

The station is on a small rocky island 9 miles ENE. of Cape Elizabeth light-station.

Halfway Rock, Maine, June 12, 1894 (*see* Chart XX).—Thermometer, 67°; sea, 61°; barometer, 30.08; wind, ESE., 3 knots; sky cloudy. The *Myrtle*, with Maj. Livermore as observer, traced the limit of audibility of the fog bell struck by a Stevens machine. To the E. and SE. of the station, against the breeze, the range was about one-third of a mile, while to the westward it was heard over 5½ miles, nearly to Peaks Island. Two miles west of the light-station the whistling buoy was plainly heard, while the fog bell was but faintly heard, although it was at the same distance.

Cape Elizabeth light-station, Maine.†—The signal is a second-class steam siren operated at pressure of about 55 pounds and a 12-inch whistle as a substitute signal. The siren and whistle are in the fog-signal house at the extreme eastern point of the cape. The siren points due south. The whistle projects through the roof of the signal house, and is, therefore, more plainly heard to the northeast than the siren is. It is very nearly equal to it in the axis of the siren.

The keeper says that just outside Taylor Reef, on the course of vessels running into Portland Harbor, the siren can not be heard with the wind easterly; that vessels

* View of this station in list of Lights and Fog Signals.
† Pls. LIII, and LXVII-LXX.

running NW. for the cape in a southeasterly wind do not generally pick up the siren until after hearing the surf break on the shore, although the siren points due south. He thinks that the siren could be better heard when it was back on the hill than it now can from near the shore because he thinks the surf kills the sounds made near the shore.

During the year ending June 30, 1893, the signals used 123 pounds of coal per hour of running.

Cape Elizabeth, Maine, May 24, 1893.—Clear afternoon, wind SW., 8 knots. The *Myrtle* ran to the whistling buoy off Old Anthony Ledge, bell A being operated on the port side forward. It was more clearly heard at 2 miles with the broadside presented than at three-fourths of a mile when averted, showing the effect of the screen.

Cape Elizabeth, Maine, September 11, 1893 (*see* Chart XIV).—The air was perfectly clear, no clouds being visible; the sun shone brightly; thermometer, 61° F., barometer, 30.3. Wind SW. from 4 to 10 knots. Balloon showed no countercurrents.

A test was made of the second-class fog siren, while the tenders *Myrtle* and *Lilac* were replacing a whistling buoy off the cape. The observers were Maj. Livermore, Mr. Wallace, and Mr. Griswold. The sound was first heard off Cushing Island, about 4 miles with the wind. It was again heard at 3¾ miles. From this point it was lost until the *Myrtle* was 1¾ miles northeast of the signal. Returning, it was lost 1 mile north of the signal because the *Myrtle* was now nearer the land that cast a shadow.

About 1 o'clock another trip was made, this time to the whistling buoy off Cape Elizabeth, and back. The siren was first heard at Trundy Reef, 2½ miles north of the signal, and directly with the wind. With but few exceptions it was heard throughout the trip until the *Myrtle* was again 2¾ miles north of the signal, when it was lost and not regained. The signal was plainly heard 2½ miles south of the cape, where the whistling buoy was planted.

Cape Elizabeth, Maine, September 12, 1893 (*see* Chart XXVII).—At noon, thermometer 65° F.; barometer 30.40. Wind varying from NE. to SE., 1 to 6 knots; sea very smooth; sky clear and bright, with sunshine during the entire day.

The keeper gave the following data in regard to the operation of the signals: Pressure on siren or whistle, 55 pounds; loss of pressure on 5-second blast; siren, no sensible loss; whistle, 1½ pounds; consumption of coal per hour, siren, 55 pounds; whistle, 50 pounds.

The *Myrtle* made a test of the second-class steam siren and the 12-inch steam whistle at this station, with Maj. Livermore and Mr. Wallace as observers. The intensity of the *Myrtle's* whistle and bell A were observed by Mr. Griswold at the cape, by Seaman Gunderson, of the *Myrtle*, at Portland, and by the keeper at Portland Head light.

From Portland to Portland Head no sound of the siren was heard, although it was in operation at the time. The *Myrtle* then ran around Cushing Island and through Whitehead Passage, hearing no sounds until the spindles were abeam, distance 6 miles from the signals, when the siren was heard for a few blasts. From Ram Island to Witch Rock buoy the signal was plainly heard, and from there to the light was observed; distance, 4½ miles, against a 6-knot wind.

Before landing at the light several balloons were sent up. The first started directly SW., and after 1½ minutes veered into a bearing NW. by N. from its starting point. The second started W. ½ S., then W. by S. until lost to view. The third started SW. by W., then veered rapidly, until it bore SW. by S., in which direction it was lost. It will thus be seen that the variations in the wind at this time were very marked.

The *Myrtle* then steamed to the S. and W. of the signal house and up behind Richmonds Island. The siren and whistle were alternating in periods of five minutes each. The signals were carried until lost to view behind Richmonds Island, when the siren

was running but was not heard. Periods of both whistle and siren passed without a single blast being heard. Crossing the point at which the whistle was before unheard, it was now plainly heard, as shown on the chart, though when the siren began sounding it could not be heard. From this position the *Myrtle's* whistle and bell A were heard from the top of the east tower at the cape, the bell being the louder. This was at 3½ miles, 15° against the wind. The *Myrtle* circled the cape and returned to Portland, the wind shifting to SSW. The signals were picked up as the signal house came in sight from behind Richmonds Island, although occasionally heard before this. The siren was carried 2¾ miles and the whistle about 3¾ miles. The *Myrtle's* whistle and bell A were heard 3¾ miles by the observer at the cape, though the bell was directed away from the observer at this time.

The siren and whistle were occasionally heard at Portland; plainly from high ground, faintly from low. Bell A was also occasionally heard by this observer, plainly when the *Myrtle* was off Portland Head light, 3 or 4 miles distant, and once faintly when she was off Cape Elizabeth, fully 6 miles across a light breeze.

Afternoon (*see* Chart XXVIII): Wind SSW., 5 knots; thermometer, 65° F.; barometer, 30.37; sea rather smooth; sky clear and brilliant. Leaving the harbor on the second trip, the *Myrtle* steamed through Whitehead Passage, hearing but one blast from the cape signals, that being from the whistle. Another blast of the whistle was heard from behind Ram Island, and soon both signals became audible, although they were alternately heard and lost on this course.

The *Myrtle's* whistle was heard at Cape Elizabeth, 5¼ miles, against a light breeze, before entering and after leaving Whitehead Passage. Bell A was heard continuously while running through the passage, while from the steamer the Cape Elizabeth whistle was but twice heard and the siren not at all. It points due south, and is screened by the buildings in the direction of Whitehead Passage.

At 5¾ miles due east from the cape both the siren and whistle were heard, the latter excelling. Bell A was not heard at the cape at this time, but was reechoed to the *Myrtle*. As these echoes ceased the bell was again heard at the cape. It was not noted whether a sail intercepted the sound, but it is quite probable that the phenomenon was so caused. The *Myrtle* next ran in a southwest course to the whistling buoy. During this run both siren and whistle were generally heard until the buoy was reached, when both were lost. The *Myrtle's* whistle and bell A were both generally heard from the cape.

Leaving the buoy 2½ miles south of the station, the *Myrtle* approached the signals, watching the steam issue alternately from the whistle and siren, but hearing no sound. This was in the axis of the siren, and was therefore more remarkable. Balloons sent up here went directly northeast, showing no countercurrents.

The wind was about 5 knots, and nearly against the sound. Nothing was heard of either signal until within one-half mile of the signal house, when the siren became audible, though but faintly.

Returning to Portland, the signals were lost at 2¼ miles with a favoring light wind. The course was near the land, which cut off the sound.

Cape Elizabeth light-station, Maine, September 25, 1893 (*see* Chart XXIX).—Wind S. 23 knots early in the test, moderating to 10 knots later. The second-class siren and 12-inch whistle were observed by Maj. Livermore and Mr. Griswold.

The *Myrtle* left Portland Head light-station about 1 o'clock, and first heard the whistle 3½ miles, almost directly with the wind. It was lost at 2¼ miles, and again picked up at 1½ miles distance northeast of the station. The short distance of audi bility agrees with the results generally obtained, viz., that strong winds cut down the range of sounds in all directions. The sound was partially obscured by land.

At 2:43 the *Myrtle* lay 2 miles to the S. by E. and the operations were resumed. Running east, the steamer passed the axis of the siren and the sound was picked up at 1½ miles distance, and carried north until lost off Portland Head light, about 4 miles, with a favoring 10-knot wind.

Cape Elizabeth light-station, Maine, September 26, 1893 (see Chart XXIX).—The Cape Elizabeth 12-inch whistle was sounded while the *Myrtle* ran east on her way to Whitehead. It was heard by the observers, Maj. Livermore and Mr. Griswold, about 6½ miles, with a 4-knot breeze in favor of the sound.

In these experiments the 12-inch whistle was manifestly superior to the second-class siren in all directions save in the axis of the siren, and its equal in that direction. It burns a little less coal.

*Portland Head light-station, Maine.**—The signal is a second-class Daboll trumpet, run by a caloric engine. It points in an easterly direction. The sound is best heard to the eastward, and the tower and building tend to reenforce it in that direction.

The signal uses 26 pounds of coal per hour.

Portland Head, Maine, September 4, 1893 (see Chart XXX).—Wind SW. to W. by S., 6 to 9 knots; barometer, 29.9; cloudiness, 0; sea, calm. Bell A, set up just south of the trumpet house, was struck a 178-foot-pound blow by the Shipman engine, which carried an average pressure of 68 pounds, and used 51 pounds of water and nine-tenths of a gallon of oil per hour. The regular fog signal, a second-class Daboll trumpet, was run at the usual air pressure of 4½ pounds, and consumed 12 pounds of coal per hour.

The *Myrtle*, with Maj. Livermore, Mr. Griswold, and Mr. Rogers as observers, ran 8 miles to the south of Portland Head, and returned. The trumpet was heard nearly 8 miles and the bell 6 miles going out, and the trumpet 4 and the bell 3 miles returning.

The failure to hear the signals as far returning as going out was ascribed to sudden changes in the wind, made evident by passing sails, whereas going out it seemed to blow much more steadily.

Whaleback light-station, New Hampshire.—The signal is a third-class Daboll trumpet mounted on a fog-signal tower to the northward of the light-house. It uses 12 pounds of coal per hour. The trumpets point a little E. of S., one each side of the lantern.

The keeper of this station says he has had many complaints from mariners, among them the following: The schooner *John Bracewell* reported hearing it as plainly 6 miles SSW. of the station as right abreast of it, but that at 2 or 3 miles away they lost all sound of it until close to it. Wind SW., moderate, fog very thick.

Fishermen report having heard this trumpet 4 or 5 miles SE. from Whaleback, but losing it at three-fourths of a mile until near the light-house. This was in a moderate south wind.

The keeper says that in a N. to SE. wind, variable and moderate, the signal has been heard 15 miles to the SE. and carried all the way to the station.

It is said that the keeper of Boon Island light came in a thick fog from Boon Island to Whaleback without hearing the trumpet until close on to the rocks. This was in a moderate S. wind.

Whaleback, New Hampshire, and Boon Island, Maine, September 23, 1893 (see Chart XXV).—The weather was cloudy and the wind SSW., 3 knots an hour. The sound thus came almost squarely across the wind, both in going and returning. The *Myrtle*, with Maj. Livermore and Mr. Griswold as observers, left Whaleback light-station at 3:25 p. m., to observe the audibility of the fog trumpet at that station. The signal is a third-class Daboll trumpet. The Boon Island bell was operated, and observations made from the *Myrtle*.

The *Myrtle* ran E. by S. from Whaleback, and was 2½ miles distant when the signal was first sounded. From this point up to 6 miles the trumpet was sometimes heard and sometimes not. At 6 miles it was finally lost, and the *Myrtle* continued to Boon Island.

On the trip to Boon Island the *Myrtle* was sounding her 8-inch whistle regularly, and also a 1,500-pound bell, which was struck a blow of about 80 foot pounds. The

*Pl. LXX.

bell was heard 6 miles on going out, and the whistle 7½ miles. On the return trip the *Myrtle's* signals were not sounded. The Boon Island bell was heard 1½ miles as the *Myrtle* left the station.

The trumpet was first heard on the return trip at a distance of 6½ miles, and then occasionaly until within 2½ miles. It was then heard continuously as the *Myrtle* approached the light.

Cape Ann light-station, Massachusetts, November 14, 1893 * (*see* Chart XXXI).—Sky clear with cumulus clouds in the west; a long swell on the sea. Barometer, 30.05 to 30.10; thermometer, 51° F.; wind, NE., about 5 knots an hour.

The *Myrtle* stopped at Thatcher Island with lumber for repairs. The observation party consisted of Mr. Wallace and Mr. Griswold. On leaving the island the whistles were sounded and observed.

The regular 10-inch whistles were used alternately in periods of five minutes each. The northerly one gives a deep tone, the southerly a shrill one of a peculiar timbre, probably caused by some loose part rattling and producing a secondary set of vibrations which destroy to a certain extent the natural tone of the whistle. The deep tone is generally preferred to the shrill one. The average pressure used is 45 pounds, requiring a consumption of approximately 100 pounds of coal per hour. It requires about an hour to steam up, starting with cold water in the boilers. The *Myrtle* steamed NE. by N. and the sound diminished regularly, the advantage being slightly in favor of the north whistle.

When the *Myrtle* was about 2½ miles NE. of the station, and about 3 miles ESE. of Halibut Point, a strong echo followed every blast of the signals. It came directly from the northern portion of the cape. The echoes were strong at first, and four repetitions were generally noticed. Sails were visible in the direction of the source of the echoes, and they were ascribed to the hills of Cape Ann. They continued audible over nearly 3 miles, and ceased to be heard when the direct sounds were lost, at a distance of about 6 miles, the direct sounds coming almost directly against the wind.

Cape Ann light-station, Massachusetts, April 5, 1894.

[*See* Chart XXXII.]

Time.	Wind.		Temperature.			Bar.	Remarks.
	Direction	Force.	Sea.	Deck.	Masthead		
P. M.		*Knots.*					
12:00	WNW.	10	39	51	52.5	29.77	Sky clouding up.
1:00	SW.	7	39	47	48.5	29.77	
2:30	W.	9	......	......	....	....	
3:30	WNW.	12	......	......	....	....	
3:00	W.	12	39	45	47.5	29.78	

Schooner *Clover*, with Mr. C. C. Livermore, Mr. Wallace, Mr. Bradley, and Mr. Griswold, as observers.

The 10-inch whistles were blown at a pressure varying from 38 to 42 pounds during the test in ten-minute periods as follows: (1) North whistle, pitch G, 198 vibrations per second; (2) south whistle, pitch A, 220 vibrations; (3) both whistles together.

As the wind was offshore the tests were made with or across the wind. They were made mainly with a view of ascertaining which of the two pitches was most desirable as a signal, and how much more powerful sounds the two whistles blown together would produce than either alone.

The *Clover* sailed S. by E. at 12:07 p. m., and at 12:30 turned to the NE. The whistles were still heard at 5½ miles. At 2:04 the course was changed to N. by W., and they were lost at 7½ miles ENE. of Thatcher Island. At 3:08 the *Clover* sailed SW. by S. and picked up the two whistles at 6½ miles NE. of the station. When the

* For view of this station see List of Lights and Fog Signals.

signal changed to the north whistle alone nothing could be heard, and this was first heard at 5¼ miles in this direction. All sounds were lost at 3¾ miles S. by W. of the station across a 12-knot wind. On this course great variations of intensity are shown with the change of signals.

Cape Ann light-station, Massachusetts, April 6, 1894.

[*See* Chart XXXIII].

Time.	Wind.		Temperature.			Bar.	Remarks.
	Direction	Force.	Sea.	Deck.	Masthead		
A. M.		*Knots.*					
8:40	N.	5	38.5	41	41	29.87	Sky overcast.
9:03	NNW.	8				29.90	Began to rain.
9:30			38.5	40	40	29.92	Raining steadily.
10:30	NNE.	12				29.92	Do.
11:00	NNE.	12	38.5	37.5	37.5	29.92	Hail, rain, and snow.

The test of April 5 was continued. The *Clover* ran SW. and carried the signal 10¼ miles across an 8-knot wind. The south whistle was blowing when the sound was lost. The two whistles were picked up at the same distance, as the *Clover* ran due east. On this course the sounds were heard and lost at intervals, due to changes in the atmosphere. At 10:37 the *Clover* sailed NW. and into Gloucester Harbor, hearing nothing on this course. The wind had increased, and the sea was very rough.

Cape Ann light-station, Massachusetts, April 7, 1894.

[*See* Chart XXXIV].

Time.	Wind.		Temperature.			Bar.	Remarks.
	Direction	Force.	Sea.	Deck.	Masthead		
A. M.		*Knots.*					
9:40	Variable.		38	37		30.10	Sea smooth.
P. M.							
12:40	S.	4	39.5	44.5		30.15	Sky clear.
2:00	SSE.	8	39	43.5		30.10	Sun shining.
4:00			39	40		30.10	Do.

The tests of the 5th and 6th were continued on the *Clover* by Mr. Livermore and Mr. Griswold, while the launch ran about the islands and alongshore with Mr. Wallace and Mr. Bradley as observers.

The *Clover* covered the area to the NE. and N. of the station, as shown on Chart No. XXXIV and great variations in sound are shown with these changes of signals. West of a line running N. by E. of the station the sound was cut off by the buildings and only faintly heard. In this space also the wind was puffy, and caused disappearances within the range of sound.

The course of the launch is shown on Chart No. XXXIV. The variations concur with the sound shadows made by the island and buildings at the station, but show nothing unexpected or worthy of further mention.

The observations of these three days show that the north whistle was stronger than the south whistle, with equal pressures; that both whistles together made a more powerful signal than either, singly, as was expected, although at an expense of twice the quantity of fuel.

As the whistles changed every ten minutes, it gave opportunity for several comparisons, which have been found to agree quite well. The relative intensities were estimated to be proportional to 10, 13, and 19, for south and north, and both whistles, respectively.

Eastern Point light-station, Massachusetts, May 4, 1894 (*see* Chart XXXV).—Morning dull and cloudy; wind east, 7 knots. At 8:52 barometer 30.23; thermometer, on deck, 48.2°; sea remained 48° F. during the entire day. The wind died down until at 10:20 there was none; barometer, 30.23; thermometer, on deck, 47.8°; at masthead,

At 11 a. m. a 3-knot SSE. breeze sprang up; sky overcast; light near horizon in south and west. At 12 m. barometer 30.22°; thermometer, on deck, 50°, masthead, 48½°; wind SSE., 7 knots. At 2:57 barometer 30.22. At 2:10 the wind died out entirely, but at 2:29 a SE. by E. breeze sprang up, and at 4:16 was 7 knots. At 4:38 barometer 30.16; thermometer, deck, 46°, masthead, 45°; and sea 48°.

The *Clover* arrived in Gloucester at 7 p. m. Thursday, May 3, 1894, with an observation party, in charge of Mr. Bradley, on board.

In the morning the launch landed at Eastern Point light-station, with instructions to ring the bell regularly used as a fog signal. This weighs 2,019 pounds, and is struck a double blow by machinery every twenty seconds; pitch F, 176 vibrations.

The *Clover* then stood out to sea. The launch ran along the shore, until the sound was lost, and then returned to the *Clover*. The signal stopped at 5 p. m., and the *Clover* lay in Gloucester Harbor overnight.

The sound was carried 1 mile to windward in a light southeast breeze, and 2¾ miles across the wind. The only peculiarity noticed was a very sudden diminution of intensity at 4:17 p. m., about 1 mile from the light in a direction at right angles to that of the wind. This may have been caused by a puff of wind. The *Clover* was running away from the bell and into the wind.

Eastern Point light-station, Massachusetts, May 5, 1894 (*see* Chart XXXV).—At 9:09, barometer 30.11; thermometer, deck, 54°, at masthead, 49°; sea, 49°; wind, southerly, 2 to 5 knots; light mist. At 9:13 the sun burned through the mist and a S. by W. wind, 5 knots, sprang up. At 9:46 the mist shut in again; barometer, 30.11; thermometer, deck, 50.4°.

At 10 the sun shone through and the breeze died out, but came up again at 10:16 from SSE., 4 knots. At 10:44 the mist had settled down again; barometer, 30.01; thermometer, deck, 57.8°, masthead, 52°; sea, 49°. At 11:15 the sun was shining hot on deck, but the shore was hidden by a thick bank of fog; wind SSE., 2 knots. At 11:36 the wind freshened S. by E.; at 11:45 the fog shut in again.

At 12 the sun came out and the wind died down; barometer, 30.11; thermometer, deck, 59°; masthead, 50°; sea, 50°. At 12:45 a SE. breeze sprang up and increased from 3 knots at 1:05 to about 12 knots at 2:30.

The morning observations were made mainly in a fog, which alternately lifted and shut down. This fog, instead of feeling damp, seemed perfectly dry, and no moisture was deposited from it. When it shut in, the sound of the bell diminished, and increased again when the fog lifted. A silent space was found about a mile to windward of the light, and sailed through twice, first in fog, and again with the light still obscured by fog, although it was clear at the schooner. On going through the same place a third time when the air was perfectly clear, the sound was heard with great intensity. The wind throughout was S. by E., very light.

In the afternoon the *Clover* returned to Boston, running out the signal to its limit of audibility, about 3 miles across the wind.

*Baker Island light-station, Massachusetts, September 22, 1893.**—The *Myrtle*, with Maj. Livermore, Mr. Luther, and Mr. Griswold as observers, ran ENE. from Baker Island lights, Salem Harbor, Massachusetts, and heard the fog bell, struck by the Stevens machine, 2¼ nautical miles. This was in a SSW. wind, about 3 knots an hour. It was a bright, pleasant day, with the sun shining.

*Minots Ledge light, Massachusetts, May 3, 1894.**—Barometer, 30.14; thermometer, on deck, 51° F.; wind SE. by S., 8 knots; sky, perfectly clear.

The *Clover* carried a party of observers, in charge of Mr. Bradley, to Minots Ledge light, and from there to Gloucester. Running from Minots Ledge, the regular fog

* View of this station in List of Lights and Fog Signals. †Pl. LXXIV.

bell, struck by hand at about 10 foot pounds, was heard 1 mile NE. from the light, across the wind, the sound diminishing regularly in intensity with distance from the light, and no peculiarities were noticed.

Minots Ledge light-station, Massachusetts, May 8, 1894 (*see* Chart XXXVI).—Fair, with light variable winds. At 1 p. m. barometer, 29.72; thermometer, deck, 68°, masthead, 68°; sea, 62°; wind, NW., 10 knots. The wind soon died down, then came very light from SSE. at 3:55, 3 knots; at 5:30, barometer, 29,83; thermometer, deck, 61°; sea, 52°.

The *Clover* went to Minots Ledge light, carrying an observation party in charge of Mr. Smith. She arrived off the light at 12:40.

Bell B, 1,040 pounds, was tested. It was struck by hand a blow of 75 foot pounds about twice a minute. This bell was on the outer platform, facing S. by E.* To the north the sound from it was obstructed not only by the tower behind, but by the regular fog bell, which was also on the platform a little to the east of bell B. The bell was started at 1:13 and continued until 5:30.

The sound was carried to the eastward a little more than 5 miles, across a very light wind. The intensity decreased very regularly, the lost intervals shown on the chart resulting largely from the slatting of the sails.

Toy balloons were released from the *Clover* and a small boat, at every opportunity. The small boat was rowed to the windward of the tower, and the balloons released so that they would pass by the tower near the lantern deck, on which the bell was set up. Their horizontal and vertical planes were located approximately by observation from the two boats.

In all cases the balloons were seen to rise uniformly, showing very little variation sidewise, the only irregularity noticed being slight "quivers" and the graceful swerving around the tower, which might be expected. The *Clover* anchored over night near Hull.

Minots Ledge light-station, Massachusetts, May 9, 1894 (*see* Chart XXXVI).—Fair; sky clear overhead, slight haze near horizon. At 8:12 barometer, 29.95; thermometer, deck, 58.5° masthead, 56°; sea, 48.5°; wind, NW., 10 knots. At 1:05 p. m. barometer 30; thermometer, deck, 62°; masthead, 60°; sea, 53°; wind, NW., 4 knots. The breeze soon died down, then came up from the SE., 12 knots, diminishing to 5 knots at 4 p. m. At 5, barometer, 30.01; thermometer, deck, 59°, at masthead, 58°; sea, 52°; wind, SE., 11 knots.

The *Clover* arrived at Minots Ledge light at 8:30. On the trip the bell was first heard at 8:24, one-half mile from the tower with great intensity, as if it had just been started, although the keeper's record indicates that the bell was struck continuously from 7:50 a. m. to 5 p. m. This may have been caused by the position of the bell and the obstruction offered by the regular fog bell mounted near it.

When the boat returned the *Clover* sailed along the south shore to a point opposite the second cliff in Scituate, carrying the sound 4¾ miles. She then sailed about NE., picking up the sound and carrying it about 3¾ miles SE. of the light; thence standing directly for the light she took off the man who had been left there in the morning, and sailed with a SE. wind, which had sprung up at about 2:30 p. m., losing the bell at 3:35, directly across the wind, at a distance of 4¼ miles. The sound was picked up again about half an hour later, running SW. for the Atlantic House at Nantasket, and heard at intervals until 4:21, when the *Clover* seemed to pass into the shadow of the tower, so she beat back across the line nearer the light.

The sound was picked up again at 4:39, and heard but faintly until it stopped at 5:03, although in this time the *Clover* had been within a half mile of the tower, with the wind blowing directly toward the observers.

Toy balloons were released, the same as the day before, at every opportunity. From 9:10 to 9:13 three single balloons and one pair were released from a small boat to the windward of the tower, so that their path lay directly by it.

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*This bell was not mounted when station was photographed; only the regular fog bell is shown in Pl. LXXIV. The bell B would appear on its left.

In dispatching balloons in pairs two were selected, such that one would rise higher than the other, and thus discover any difference of wind velocities which might exist at different heights. One pair was released at 9:27 from the *Clover*, one singly, and four in pairs from a small boat at 2:10 and 2:12 p. m., besides several single ones at various times during the day.

All the balloons this day showed no appreciable difference in horizontal velocities at different heights. They rose uniformly and regularly, occasionally showing little eddies, and always swerving steadily around the tower.

The *Clover* lay at anchor overnight near Fort Warren.

Minots Ledge light-station, Massachusetts, May 10, 1894 (*see* Chart XXXVII).—Fair; sky perfectly clear and cloudless all day. At 8 a. m., barometer, 30.22; thermometer, deck, 53°, masthead, 51°; sea, 48°; wind, NE. to ENE. all the morning; at 8:45, 9 knots; at 11, 12 knots; at 11:30, 8 knots. At 12 m., barometer, 30.26; thermometer, deck, 54°, masthead, 54°; sea, 50°; wind, SE. by S., 12 knots in the afternoon. At 4:57, barometer, 30.31; thermometer, deck, 51°, masthead, 51°; sea, 48°.

Bell B was started at 8 a. m. and struck continuously until 5 p. m. The sound was first heard on the *Clover* when about two-thirds of a mile N. by W. from the tower across a NE. wind.

A boat left the *Clover* with a man to strike the bell, one to observe balloons from the tower, and one to release and observe them from the boat.

The balloons were released 250 feet from the tower, to study the currents directly at the light. The notes by Mr. Butterfield, who was on the tower, are more reliable than those of the other two parties, whose positions were such that the balloons sailed directly away from them. Mr. Butterfield's notes are here given:

"9:18. First balloon passed 100 feet north of tower and was about 50 feet from the water; rose very slowly; no sudden change in either horizontal or vertical velocity; no eddies observed.

"9:20. A pair rose uniformly from boat and passed 4 feet above ball of tower, one on each side of lightning rod. They were about 4 feet apart horizontally and 2 feet vertically when passing ball of tower. Not the least eddy was observed, and they kept the same gradual rise and relative positions after passing tower.

"9:22. A pair, red and green; rose gradually in passing the tower. The green one was about 30 feet from tower and on same level as top of tower. The red one came straight for the tower, but made a swerve around it at height of lantern deck; after passing tower, the green one which was above and south of the red one, passed over and seemed to be about 20 feet to the north of the red one, and seemed to gain a little in vertical velocity.

"9:24. A pair, rose gradually; passed tower at height of lantern deck and about 15 feet away, both made a slight swerve, very close together, both horizontally and vertically over the other, a few feet above it, and afterward no change was noticed."

When the observers were again aboard, the *Clover* sailed over a triangular course to windward and back to the light. A party went into the light and adjusted the spiral spring so as to get a blow of about 150 foot pounds energy.

Upon their return to the *Clover*, she again sailed over the same course as in the morning, but with the wind in the SE., and heard the bell about three-fourths of a mile directly to windward.

When again opposite the light she sailed N. by W. almost directly with the wind and ran the sound out at 3 miles, then beat back and heard the bell from 4:32 until it stopped at 5:03 p. m.

*Boston and Minots Ledge light-stations, Massachusetts, May 11, 1894** (*see* Chart XXXVII).—At 10:30, barometer, 30.32; thermometer, on deck, 54°; sea, 48°; sky fair, but horizon hazy; wind, SSE., 18 knots; sea, choppy. By noon clouds had come up rom the west and hid the sun. Wind, S., 20 knots; sea choppy, wave heights, 4 feet. At 2:30 a few drops of rain fell; barometer, 30.23; thermometer, on deck, 57°;

*For description of Boston light-station, see above in account of experiments at this station, also Pl. LXXI-LXXIII.

sea, 48°. Rain threatened until 4:30, when the wind died down and it became clearer. At 5, barometer, 30.25; thermometer, on deck, 53°; sea, 48°; wind, SW., 8 knots. Sea fairly smooth, sky cloudy.

The *Clover* started for Minots Ledge at 7 a. m. A little east of Boston light the *Myrtle* came alongside. After a consultation with Maj. Livermore the *Clover* again got under way for Minots Ledge. When she came near the light the keeper displayed a danger signal, and the *Clover* kept off and beat out to windward about 6 miles, then ran for the light directly with the wind. When 1¼ miles from the light bell B was heard for the first time, but it was found later that during the greater part of the run to windward the bell was not ringing.

The *Clover* then ran NNW. and lost the sound about 1¼ miles from the tower, across the wind and somewhat behind the light. Coming back on almost exactly the same course the bell was not heard until within about one-half mile. As the bell was rung by hand and no observer was stationed at the tower, it is not impossible that on this course the hammer was not drawn back to the stop so as to give the proper strength to the blow.

The *Clover* then ran NE., with the 13-knot wind, and heard the bell 4 miles. Then running for Boston light, it was heard at intervals until it stopped at 5 p. m. On this run the trumpet with the 50-foot extension at Boston light was plainly heard more than 10 miles across the wind, and was not run out to the limit of audibility.

The *Myrtle* also went down the harbor this day to land materials, with Maj. Livermore, Mr. Luther, Mr. Wallace, and Mr. Bradley as observers.

The signals tested were the third-class Daboll trumpet, with 50-foot wooden extension, bell C at Boston light, and bell B at Minots Ledge. Bell C had been cracked at the previous test, and was on this day struck a blow of 175 foot pounds.

A short test of the trumpet, up to 1 mile distance, was made between 11 and 12. At 1:25 the *Myrtle* started for Minots Ledge, and bell C was heard 1¼ miles across the wind. Bell B was not heard until one-half mile from Minots Ledge. The *Myrtle* ran by the light three-fourths of a mile to the NE., both going and returning; wind, S. by W., 16 knots. It was struck by hand and may not have been struck as hard as usual.

While lying at Minots Ledge the trumpet at Boston light was faintly heard across the wind, distance 6¾ miles. The *Myrtle* started for Boston light at 3:33, and lost the sound of bell B at three-fourths of a mile. Bell C, at Boston light, was first heard at 1¼ miles. The trumpet was heard with increasing intensity during the entire run.

Minots Ledge light-station, Massachusetts, May 12, 1894 (*see* Chart XXXVIII).—Fair; sky clear except bank of dark clouds in west. At 9:15, barometer, 30.31, thermometer, on deck, 60°; sea, 50°; wind, N., very light. At 10:23 a breeze came up from the east, 6 knots. At 1:08, barometer, 30.32, thermometer, on deck, 57°; sea, 50.5°; wind, E. by S., 7 knots. The *Clover* was under way at 7:10 a. m.

The bell was started by the keepers at 8:56, and they were relieved by men from the *Clover* at 9:23. The signal was stopped at 12:30. The bell was first heard on the *Clover* 1¾ miles NNW. of the light, and not again until the seamen began striking at 9:23.

At this time the observers thought they detected a very clear echo from the Cohasset shore, and the party went off in the launch to discover, if possible, the source and genuineness of the echo. The launch ran toward Cohasset about a mile, then toward the Atlantic House to a point 2 miles from the light, thence down through the Gangway to a point near South Entering Rock, off the north Scituate shore and then to the light.

No echo was heard at any time during the trip, and it turned out that the regular fog-signal bell of the station had been ringing at the time when the supposed echo was heard. It was much fainter and had the same pitch and was struck at the same interval, and ignorance of the fact that it was in operation made the delusion complete.

The *Clover* sailed north and carried the sound 3 miles across the wind, thence

south by east; the bell was lost 3½ miles to windward. On the return to the light the sound was heard until the bell stopped at 12:30. The *Clover* then went back to Boston.

During these five days' tests no irregularities were noticed. The results of observations under similar circumstances would probably have been more uniform had the bell been struck a more uniform blow.

Boston light-station, Massachusetts, October 30, 1893, (*see* Chart XXXIX).—The wind was light from the NW. during the early part of the afternoon, but hauled into the SW. about 4 p. m. It shifted considerably during the day. Sky bright and clear; sea smooth, with a slight swell.

On October 30, 1893, the *Clover*, *Geranium*, and *Myrtle* cruised in the vicinity of Boston light and recorded observations of the intensities of the fog siren at that station. This is a regular first-class steam siren, and was operated at a pressure of about 55 pounds. It points E. by S. and covers the course of vessels coming from Minots Ledge light.

The observers were as follows: On the *Myrtle* were Maj. Livermore, Mr. Johnson, and Mr. Wallace; on the *Clover*, Dr. C. A. White; on the *Geranium*, Lieut. Commander Colby, U. S. Navy, and Prof. H. A. Hazen.

The *Myrtle* ran directly to the eastward of Boston light and returned. The *Geranium* ran down by Minots Ledge and returned, while the *Clover* cruised over a course crossing the paths of the *Myrtle* and *Geranium* and lying to the east and southeast of Boston light.

The *Myrtle* and *Geranium* found a range of about 11¾ miles to the east and southeast, and no peculiar occurrences were noticed. The course of the *Clover* showed, in general, a greater intensity than those of the other tenders, which was undoubtedly due to the difference in the observers.

Boston light-station, Massachusetts, October 31, 1893 (*see* Chart XL).—Wind strong from the NE. during the morning, shifting to the S. and moderating late in the afternoon; sky clear, with cirrus clouds in the horizon; sea choppy, with a ground swell; thermometer, dry bulb, about 39° F.; wet bulb, 32.6° to 34° F.; barometer, 30.46.

The observations of October 30, 1893, were continued with the same observers and tenders. Mr. Johnson was aboard the *Clover* and Dr. White aboard the *Myrtle* for the day.

The *Myrtle* ran E. about 5 miles, then NW. by the Graves whistling buoy to Nahant, through Broad Sound to Deer Island light, and back to Boston light.

The *Geranium* ran SE. to Minots Ledge light and returned, then NE. to the Graves whistling buoy, SW. to Nix Mate and then to Boston light. The *Clover* ran E. and then S.

The siren was heard about 5 miles to the E. and SE., but somewhat less to the north. Behind Great Brewster Island the *Myrtle's* observers found some interesting echoes. Then running south for Boston light about 3 o'clock the siren was inaudible. It was picked up at 3:15 at a distance of 2¼ miles from Boston light and behind the Brewster Islands. Turning to run west at 3:20 a series of echoes were heard. These were repeated four times at 3:29, when the *Myrtle* lay directly behind Great Brewster Island from the light-house; at 3:31 the echoes ceased. They were, perhaps, due to sails of vessels in the vicinity which were in a position to reflect the sound rays to the *Myrtle* at the moments of audibility of the echoes. The direct sound of the sirens continued to be heard until 4:11, when the *Myrtle* passed directly behind the highest point of Great Brewster Island, and the station became entirely hidden from view.

The steamer also succeeded in getting a double echo of her own whistle from two sails in almost the same direction, but at different distances.

Boston light-station, Massachusetts, January 23, 1894 (*see* Chart XLI).—The temperature varied from 33° to 41° and back to 32° F. during the day; barometer from

30.44 to 30.52; wind SW. until 2:40 p. m., when it shifted to SE.; velocity about 2 knots an hour. After 4 o'clock the wind freshened, and at 4:40 p. m. was 5 knots. Sea smooth, wave heights about 2 inches; sky about one-third cumulus clouds.

The *Myrtle* tested bells at the experimental house at Boston light. A party at the station in charge of Mr. Adams sent up and located toy balloons for the purpose of studying the wind currents in the vicinity of the light-station. Maj. Livermore, Mr. Luther, Mr. Wallace, and Mr. Rogers, on board the *Myrtle*, went to the eastward, observing the signals. Bell C, weight 4,000 pounds, was struck by a 2-horse power Shipman kerosene engine, and a hammer weighing 405 pounds, operated by an elliptical spring of 10 leaves of ½-inch by 2-inch steel. Length of stroke, 18 inches. Force of blow, 350 foot-pounds.

Bell B, weight 1,040 pounds, was rung by drawing a hammer back to a fixed position, by hand, and letting it return by means of springs. The force of blow was 148 foot-pounds.

The *Myrtle* left the light-station shortly after noon, ran E. by S., and at 12:33 lost the sound of both bells at 2 miles distance. Turning to run for the light to ascertain the reason, they were again heard. The *Myrtle* resumed her course, the wind gradually diminishing to a calm. Bell B was first lost at a distance of 9 miles, but again heard for a minute at 10 miles. Bell C was heard 11¼ miles, after which it stopped ringing.

Returning, the signals were heard when first sounded; distance, 7 miles, and from 3 to 1 miles ESE., the signals were silent. This was a remarkable "ghost." (*See* chart.)

Although from the chart it would appear that the bells were nearly equal in penetrating power, the big bell was much clearer and more readily picked up than bell B, and might have been heard farther, had it not been stopped at this time. Bell C had a peculiar boom, which could be heard from one blow to the next, and was very similar to the sound of a whistle. The pitch of bell C is the octave below middle C of the pianoforte, or about 132 vibrations per second. Bell B has the pitch A, below middle C, or 220 vibrations.

Boston light-station, Massachusetts, January 31, 1894 (*see* Chart XLII).—The wind was WNW., blowing 18 knots per hour at 2:30; thermometer, 40° F. at noon, but 38° F. during the test; barometer, 29.90. The sky was blue and clear, with but few clouds, and these were in patches near the horizon. There was a slight swell on the sea. The wind was 25 knots about noon, but moderated. At 2:48 it was 9 knots, but soon rose to 16 knots, and remained from 16 to 18 knots during the remainder of the test.

Mr. Adams and party remained at Boston light-station, while Maj. Livermore, Mr. Luther, and Mr. Wallace joined the *Myrtle* and tested the signals.

The signals operated during this test were (1) regular steam fog siren (first-class), operated in the usual manner; the rate of vibration was 330 per second; the pressure carried was about 40 pounds. (2) Bell C, operated by the Shipman kerosene engine, and struck a blow of 348 foot-pounds energy; (3) Bell B, struck by hand and springs, with a blow of 348 foot-pounds energy. When 2 miles east of the station the regular intensities of the signals were estimated: Siren, 10; bell C, 4; bell B, 1.

The *Myrtle* left Long Island at 2:32 and steamed to Boston light over the regular course. No sound of the signals was heard until off False Spit beacon, 1 mile to the westward of the signal house. At this point the siren was very faint. It gradually increased as the *Myrtle* approached the light, but was at all times very faint in this direction, as it was obscured by the buildings at the station.

Starting back toward the Narrows light the signals were all lost at three-fourths of a mile west of the light, the bells becoming inaudible at about one-third of a mile. At False Spit beacon nothing could be heard of any of them. The *Myrtle* now turned to run east and passed the light at 3:26 p. m.

The sound of the siren was picked up at three-fourths of a mile and the bells at one-third of a mile. Passing the light the sound became louder and was carried to

the eastward $2\frac{1}{4}$ miles, where it was estimated at 50. The observations were then discontinued.

The pitch of each signal was determined: Bell C, pitch C, 132 vibrations per second; bell B, pitch A, 220 vibrations per second; siren, pitch about D, or 330 vibrations.

Boston light-station, Massachusetts, February 7, 1894. (*see* Chart XLIII).—Wind WSW. 20 knots, as the *Myrtle* left Boston light, continued blowing from the same quarter, although decreasing in velocity, until about 4:20 p. m., when it was changed to SSW. The day was damp and the sun was obscured by clouds. The thermometer averaged 40° F. and varied but little during the test. The barometer remained about 30.10. The balloons went straight away until lost to view. The sea was quite smooth. The *Myrtle* made observations on the audibility of signals at Boston light; bells B and C were rung continuously, bell B by hand and springs, with a force of 150 foot pounds; bell C by Shipman kerosene engine, with a force of 150 foot pounds.

The other signals alternated in half-hour periods, the first period being assigned to the trumpets, the next to the whistle, and the next to the sirens.

The trumpets were the 10-inch experimental trumpet, constructed at the repair shop at Boston, Mass., and a third-class Daboll trumpet blown by compressed air of 3 pounds pressure. The 10-inch whistle was blown once a minute at an average air pressure of 5 pounds. The sirens were operated at a pressure of about 15 pounds one by air pressure, the other by steam.

At 3 o'clock the air pump broke down and the trumpets were discontinued. The other signals continued until 5:10 p. m. The *Myrtle* left the light at 1:05 p. m. and ran to Minots Ledge light, arriving at 2 o'clock. The observers were Maj. Livermore, Mr. Luther, and Mr. Wallace.

The intensity of the bells decreased regularly until 1:35, when at $3\frac{1}{4}$ miles all signals were lost. This came at a time when the trumpets were in operation, and continued when they had been succeeded by the whistles. The sirens were not in operation at this position. At $5\frac{1}{4}$ miles the bells were again picked up, and carried from there to Minots Ledge light. The observers left the *Myrtle* and went into the light tower, remaining an hour or more on business connected with the change of lens. Both bells and the steam siren were plainly heard, the latter being especially distinct. This was across a 14-knot wind, a distance of $6\frac{1}{2}$ miles.

The *Myrtle* left Minots Ledge light at 3 p. m. and arrived at Boston light at 4:59. The trumpets were heard about $1\frac{1}{4}$ miles. The large trumpet, however, was not in smooth running order. The sirens were both plainly heard most of the time, the steam one being always the louder, as it was operated at a higher pressure.

The most remarkable occurrence noted, aside from the temporary inaudibility mentioned, was the range of the bells, which was fully $7\frac{1}{2}$ miles.

Boston light-station, Massachusetts, February 28, 1894 (*see* Chart XLIV).—Wind S. by W. $\frac{1}{4}$ W., 12 knots an hour. Balloons went direct with no countercurrents. Thermometer, 33° F.; barometer, 30.42; sea smooth; sky clear, with but few clouds. The *Myrtle* ran to the south and east of Boston light-station. The observers were Maj. Livermore, Capt. Tower, and Mr. Wallace. Signals observed:

The signals were a first-class siren at a steam pressure of 14 pounds, a first-class siren run by air pressure, a 10-inch whistle at the top of the signal house, at an air pressure of 11 pounds, and a 6-inch whistle at the top of the tower, at an air pressure of 11 pounds.

It was intended to keep a pressure of 14 pounds on the air siren, but it could not be kept above 11 pounds.

Bells D and C were also rung with blows of 150 and 350 foot pounds, respectively, and the former was broken on the twenty-fourth blow, before observations of its intensity had been made. This was the 1,000-pound "Blymer" bell made by the Cincinnati Bell Foundry, of Cincinnati, Ohio.

The estimated ratio of intensities of the signals at a short distance in the axis of the siren was, steam siren, 8; air siren, 5; bell C, 4; 10-inch whistle, 2; 6-inch whistle, 1. Directly east of the light and without the axis the ratio was, steam siren, 7; bell C and air siren, 6; 10-inch whistle, 3; 6-inch whistle, 1. It must be remembered that the bell was rung with its full power, while the other signals were not, and that in the air siren the proposed pressure could not be maintained.

To the east of an imaginary line from Boston light to Point Allerton beacon the signals were plainly heard, but to the west they were scarcely heard at all, on account of the buildings at the light-station, which reenforced the sound to the eastward, and cut it off to the south and west.

Observations were made at the masthead and the signals were generally better heard there than on deck.

Boston light-station, Massachusetts, March 22, 1894 (*see* Chart XLIV).—The wind was due east, 9 knots, during all the test; sea, smooth; sky, almost cloudless; temperature, 46° F., and barometer, 30.10. Bell C and the third-class Daboll trumpet were tested. The course was E. by S. of Boston light, and the intensity represented is that of bell C. The trumpet was not heard as well as the bell. The observers were Maj. Livermore, Mr. Adams, Mr. Wallace, Mr. Bradley, and Mr. Griswold.

On leaving the light-station at 2:20 p. m. the *Myrtle* ran E. by S., and lost the sound at a distance of less than three-fourths of a mile. The *Myrtle* was stopped and all listened. No sound could be heard, although bell C rang every 10 seconds from 2 until 5:10 p. m., with a blow of 350 foot pounds. The trumpet was stopped at this time, but it is not probable that it would have been heard, as the bell was the stronger signal.

After determining the position the *Myrtle* went on at half speed, and at 1½ miles the bell was heard at an intensity estimated at 5. The *Myrtle* continued eastward, and the sounds of the signals increased, until at 3 p. m., 3½ miles out, they were estimated at 35 and 40. From this point the intensity decreased rapidly, and at 4½ miles from the station they were but faintly heard.

The *Myrtle* then ran for the light, and at 5½ miles the signals were estimated at 25 and 7, the bell being the stronger. They then diminished, and at 4:04 were lost. They were picked up at 1½ miles and carried to the station, increasing normally.

A very important phenomenon was the clear sound of a tug's whistle from up beyond Boston light, when the *Myrtle* was in the very heart of the "ghost," and the fog signals were inaudible. The tug was abreast of the Centurion, about 1 mile beyond the light-station, yet the sound of its whistle rang out clear and loud.

Observations were also made from aloft, and the signals were better heard than from on deck. Within the "ghost," however, nothing could be heard.

Boston light-station, Massachusetts, March 24, 1894 (*see* Chart XLV).—The weather was clear, the sky dotted with fine cirrus clouds, and the sun shone brightly; temperature, 40° F.; sea smooth at first but rougher about 3:20, as it grew colder; wind, E. to SE., 12 to 17 knots. Observers on the *Myrtle*, Maj. Livermore, Mr. Wallace, Mr. Bradley, and Mr. Griswold; on the *Clover*, Mr. Adams, Mr. Butterfield, and Mr. Dahlgren.

The *Myrtle* steamed to the eastward and recorded the intensities of bell C and the third-class Daboll trumpet at Boston light, and bell B on a scow moored in midstream between Boston light and Point Allerton beacon.

The *Clover* spent the day observing currents of air, as shown by toy balloons.

The third-class Daboll trumpet was blown twice a minute by compressed air of 4 pounds pressure. Bell C was rung every 10 seconds by the Shipman engine with a blow of 348 foot pounds; bell B by the Kane engine with a blow of 133 foot pounds. A small brass cannon—bore 3½ inches—of the Lyle pattern used in the life-saving service was occasionally fired from the northeast corner of the island with a 2-pound charge of coarse gunpowder.

The *Myrtle* started from the scow at 2:37 and ran to the eastward. When about

1¼ miles ESE. Maj. Livermore noticed that the sounds had ceased, but as they were soon heard again the *Myrtle* continued.

From this time no very noteworthy observations were made, except that the sound of all signals was lost for a moment at 3:28 o'clock, due, no doubt, to a sudden puff of wind, for they were soon regained.

At 2:49, when distant 1 mile from the station, the sound of the gun was plainly heard on board the *Myrtle*. It was about as loud as bell C, and both were much louder than bell B or the Daboll trumpet.

At 3:21 the second gun was heard, the *Myrtle* being 4½ miles E. by S. of the station. This time it was merely a faint pop, not nearly as loud as bell C or the trumpet. Bell B was soon lost, and at 4 p. m. the scow was towed back to Boston light and the bell stopped, as the sea was becoming rough.

At 3:41 the third gun was plainly heard, distance 5¼ miles, and was louder than either of the bells or the trumpet. A gun fired at 4:25 was not heard, although the smoke was seen. This was when the other signals were not heard.

The next gun was fired at 5, and was plainly heard about 3 miles. The bell C and the Daboll trumpet were also plainly heard. At 5:06 the *Myrtle* passed Harding Ledge, 2½ miles from Boston light, and in running to the light encountered a remarkable silence.

Not a sound of the signals were heard from Harding Ledge to within one-fourth of a mile of the station. The audibility of bell C is shown on the chart. No sound coming from Boston light penetrated this space, 2 miles in length. As the *Myrtle* left Harding Ledge a gun was fired at Boston light, but was not heard. Again at 5:26, when within a mile of the station, the puff of smoke was seen, but no sound was heard from the gun, bell, or trumpet.

At 5:34, off the western end of Shag Rocks, and about one-fourth of a mile from the station, the signals were first heard, the gun, bell C, and the trumpet coming out plainly together in the above order of intensities. To establish more definitely the limit of audibility the engine was reversed and backed about 50 yards, when the sounds went out entirely and were not heard either from the deck or masthead.

The *Myrtle* then ran ahead slowly with two observers at the masthead and two on deck. It was first heard at the masthead. Two observers now started down the mast, and at each step noticed a decided loss of intensity of the signals, until, on arriving at the deck, they had finally lost fully two-thirds of their intensity aloft. The boundary was established and the observations discontinued. This was one of the most remarkable "ghosts" yet recorded.

The wind had changed to SSE. as the *Myrtle* entered this silent area, blowing almost directly against the sound at the rate of 17 knots. It was ebb tide all the afternoon.

Boston light-station, Massachusetts, March 29, 1894 (*see* Charts XLVI and XLVII).—The day was cloudy, with short periods of rain and snow. Temperature of the water varied from 37½° to 37°, the wet-bulb thermometer from 39° to 34½°, and the dry-bulb thermometer 38.5° to 33½°. The masthead temperatures agreed with those on deck throughout the day. Barometer, 30.14 to 30.02; wind, S. to SW., 15 knots.

On the *Myrtle* the observers were Maj. Livermore, Mr. Wallace, Mr. Bradley, and Mr. Griswold. On the *Clover*, Mr. Adams, Mr. Butterfield, and Mr. Dahlgren.

The observations were made between 1 and 4 p. m., and the tenders covered the territory from Boston light to Minots Ledge light. The *Myrtle* ran down outside Harding Ledge spindle, returning inside. The *Clover* ran down inside the spindle, returning outside. The following signals were tested:

The steam siren, with a pressure of about 20 pounds, was blown an occasional blast until 4 p. m., when a fog shut down, after which it was run with the usual pressure of 40 pounds and the other signals were discontinued. The eastern siren was blown occasionally at an air pressure of about 15 pounds. An 8-inch locomotive whistle, mounted at the top of the light tower, was operated at an air pressure of about 10

pounds. Bell C was rung every 10 seconds with a blow of 348 foot pounds by the Shipman engine. A Lyle gun was fired three times, with a charge of 2 pounds of coarse powder, from the northeast part of the island. A 10-inch whistle above the temporary fog-signal house was operated at 15 pounds air pressure.

The steam siren was in operation from the start until 2:10, and after 4, and the other signals in turn between these times.

The 8-inch whistle at the top of the tower was heard as follows: At 2:08 a blast was heard at both vessels, *Clover* 6 miles away, *Myrtle* 3½ miles. At 2:12 the blast was not heard at either vessel, although they had moved only one-half mile and the pressure was the same as before. After 2:40 it was seldom heard, probably because of the fall in pressure from 20 to 10 pounds, which occurred about this time.

The 10-inch whistle was somewhat more effective, although it was equally inefficient when the pressure had fallen below 15 pounds; neither signal was heard a mile with the pressure below 15 pounds. The maximum range was 6 miles, although it could evidently have been heard farther, if there had been opportunity to make the trial.

The air siren began its intermittent blasts at 2:20 and until 2:40 was well heard, the distance being 5 to 6 nautical miles. It became inefficient with a fall in air pressure.

Steam siren: The pressure was at first about 40 pounds, and this was then the most powerful signal. At 2:10 the pressure was allowed to run down, and from this time until 4 p. m. it was between 25 and 12 pounds, running down gradually. At 4 the steam was again raised to 40 pounds and the signal run regularly.

Bell C: By far the most interesting results of the day were from the 4,000-pound bell, which was heard over 6 miles and was stronger than all other signals. This was at the limit of the run in the vicinity of Minots Ledge light.

It had been raining all the afternoon and at about 3:40 it began to snow and rain simultaneously. The observers on both tenders noticed an immediate improvement in the sound, and the *Clover* picked up the bell as soon as the snow commenced, although it had not been heard just previous to this time.

Boston light-station, April 24, 1894 (*see* Chart XLV).—The *Clover* was sent, April 23, to Boston light to make such tests as were possible of the third-class Daboll trumpet, with the 50-foot extension, and bell C. Mr. Wallace, Mr. Griswold, and Mr. Bradley were detailed aboard the schooner as an observation party.

April 24, at 8 a. m., a thick mist, which gradually cleared. At 11:40, only slightly hazy; barometer, 29.89; thermometer, on deck, 50°, at masthead, 47°, sea, 44°; sea very smooth. A dead calm lasted all day. At 2:30 clouds came up from the north and east, soon hiding the sun. At 3:11 it began to rain; barmometer, 29.88; thermometer, on deck 48.5°, at masthead 46°, sea 45°.

During the tests on this and the following days bell C was struck a blow of 350 foot pounds every 10 seconds, and the second-class Daboll trumpet, with a 50-foot extension, was run with 6 pounds pressure.

The signals began at 8 a. m., with the *Clover* about 1½ miles east of Boston light. Fog soon shut down, so that the regular fog siren was sounded. The fog held about an hour and a half, then burned off and it was quite clear, though a little hazy in the horizon. The *Clover* now drifted over the course indicated in the chart.

The only peculiar appearance noted was the faintness of the bell behind Harding Ledge spindle. In general the bell was far superior to the trumpet; the *Clover* was not, however, in the axis of the trumpet when it was blowing.

A party in the launch compared bell C with the trumpet in its axis. They ran across the mouth of the trumpet at various distances from one-half mile to 2½ miles, and found that the trumpet was superior to the bell in the axis, equal to it at about two points from the axis in either direction, and inferior to it at wider angles than two points.

The trumpet worked admirably and was very powerful in its axis. It appeared to make little if any difference in the intensity, whether the observers were one-half

or 2½ miles from it, so long as they were in the axis, but the least deviation from this line was immediately evident from the falling off of the sound. The party found itself able to bring the launch into and out of the axis by the sound, a property which would be very valuable in a fog signal if it could be depended on.

Boston light-station, Massachusetts, April 25, 1894 (*see* Chart XLVIII).—At 12:30, barometer, 30.12; thermometer, on deck 46°, at masthead 45°; sky clear and perfectly cloudless; wind SE., 5 knots; sea gently rolling. At 2:30, wind, SE., 9 knots. At 4:30, barometer, 30.02; thermometer, on deck 47°, at masthead, 46°, in water, 45°; wind SSE., 9 knots; sky clear and cloudless; sea slightly rolling.

It was found impossible to arrange the work at the light so as to run the signals all day, so it was decided to sound them from 12:30 to 4:30 p. m. only.

At 12:30 the *Clover* started. The launch could not be used as the water was very rough.

The chart of the trumpet shows the great change in running across the axis. The intensity of the bell was much more regular, decreasing as the *Clover* left the light. No unusual phenomena were observed. The wind was SE., yet the sound was carried SE. of the light in good shape, and no silence observed near the station. In general the bell was heard better, but the trumpet was superior to it in a direction not more than two points either side of the axis. At 6 miles distant the axis of the trumpet was plainly evident from the sound. This was the first time that the signals had been heard with regularity for so great a distance against the wind.

Boston light-station, April 26, 1894 (*see* Chart XLIX).—At 12:30, barometer, 30; thermometer, on deck and at masthead 60°; sea, 47°; wind W., 7 knots; sky clear, with a few cirrus clouds; sea smooth. At 1, wind, WSW., 8 knots, and at 2:10 S. by W., 7 knots. At 2, thermometer, on deck and at masthead, 65°, sea 50°. No more observations of the temperature at masthead were taken, for the thermometer there could not be kept out of the sun during the rest of the test period. At 2:30, thermometer, on deck, 56°; wind, S., 7 knots; while at 3, thermometer, on deck, 62.3°; wind, SSW., 6 knots. At 3:30, wind, W. by N., 7 knots; at 4, WSW., 8 knots. At 4:30, barometer, 29.96; thermometer, 61°; wind. W. by N., 8 knots; sky clear, with a few light cirrus clouds; sea smooth.

The signals started at 12:30 p. m. The *Clover* ran out in the axis of the third-class Daboll trumpet, arranged with the 50-foot wooden extension, until the sound was lost at 9 miles distance. She then tacked back, crossing axis twice on her return to the light. In the axis the trumpet and bell were heard with intensities relatively as 4 to 3 when within 3 knots, and 2 to 1 between 3 and 8 knots of the light. The trumpet on this day showed plainly the influence of the extension.

Boston light-station, Massachusetts, April 27, 1894 (*see* Charts L).—Morning clear; wind light, in gusts, from every quarter of the compass. At 12 noon, barometer, 30.02; thermometer, on deck and at masthead, 69.5° F.; sky clear, with a few cirrus clouds; sea very smooth. At 1:30 a balloon sent up; rose vertically for quite a distance until it struck an upper current. These conditions held until 2:45, when a brisk southwest wind sprang up. At 3 the barometer was 29.98; thermometer, 67.5° F.; wind, SW., 20 knots, and remained so during the rest of the day; slightly hazy near the horizon. At 4:30, barometer, 30; thermometer, 67° F.; horizon hazy with a few clouds in the northwest; wind, SW., 20 knots; sea choppy.

The *Myrtle* went to Minots Ledge light in connection with work on the lens there, and on her way stopped at Boston light and left orders to have the Daboll trumpet and bell C started. Maj. Livermore and Mr. Luther made observations on the trip to and from Minots Ledge and between landings there.

The trumpet began to sound at 9:28 and was then observed until 9:54, when the *Myrtle* anchored at the Minots Ledge tower.

At 11:35 the *Myrtle* ran north, over a course shown on the chart. The sound of the trumpet increased as the *Myrtle* came more directly into its axis, though not very much. The *Myrtle* then ran NE. for about 5 miles, the trumpet being heard all the

time, while bell C was lost at about 1¼ miles from Minots Ledge. Throughout this trip the trumpet was louder than the bell. The range of the trumpet was about 7¼ nautical miles, while the bell was heard about 7¼ miles. The difference in the sound of the trumpet within and without its axis was not noticed on this day at this distance, although on some other days it was marked.

Owing to the absence of wind the *Clover* did not get far from Boston light until the breeze sprang up at about 2:45, when she ran for Minots Ledge light.

No peculiarities in the sound were noticed. The sound of the bell and trumpet diminished with regularity until lost at 3:08 at a distance of 5¼ miles. The trumpet was lost first, then the bell.

Boston light-station, Massachusetts, April 28, 1894 (*see* Charts XLIX and L).—Hazy, with the sun more or less clouded over all day. At 10:45, barometer, 30.01; thermometer, on deck, 71°, at masthead, 73°; wind, SW., 6 knots. At 11:40, thermometer, deck, 64°; wind WSW., 17 knots. At 12:07 wind was W., 10 knots; at 1, 6 knots, remaining so until after 2, when it freshened, and at 3 was 11 knots. At 2, thermometer, on deck, 71°, masthead, 70°; barometer, 29.90.

The *Myrtle* again went to Minots Ledge in connection with the work on the lens there and incidentally to test the signals at Boston light. The *Myrtle* spoke the *Clover* off Boston light about 10 in the morning, and told her to keep within about 5 miles of the light.

The signals used were the same as on the previous four days—bell C, struck by the Shipman kerosene engine, and the third-class Daboll trumpet, with the 50-foot wooden extension. The trumpet was started at 10:42, the bell at 11:10.

The *Clover* ran away from the light, then over near Harding Ledge, then across the axis of the trumpet, and back. The limit of audibility of neither the bell nor the trumpet was fully run out. The only peculiarity in the sound of the bell was noticed off Nantasket Beach, near the shore, where the sound seemed weaker than farther out to sea. The same thing was noticed with the trumpet. A marked diminution in the sound of the trumpet was noticed at 2:45, near the light, but as the bell continued to sound with undiminished intensity the trouble may have been partly with the blowing apparatus of the trumpet. A few minutes later the bell cracked. The signals stopped at 3:30 and the *Clover* returned to Boston.

Maj. Livermore and Mr. Luther, on the *Myrtle*, made observations on the signals between the landings at Minots Ledge light. The *Myrtle* left Minots Ledge at 12:15 p. m., running due north. The trumpet was louder than the bell all the way down this course, and from the turning point, 5¼ miles E. by N. of the Boston light-station till the *Myrtle* arrived at Harding Ledge, when the signals became equal.

The *Myrtle* now circled around the Harding Ledge spindle at a radius of about a mile, the bell being the louder signal, until Boston light bore about E. by S., when the trumpet came out with great intensity, and far louder than the bell. The course now lay for Minots Ledge light, and the trumpet remained the louder until the light was reached at 2:12. At 2:37, the *Myrtle* being ready to leave the light, observations were resumed.

The course lay NE. to the axis of the trumpet, then for Boston light. Throughout this run the trumpet was louder than the bell, the difference being the more noticeable as the steamer came into the axis.

Boston light-station, Massachusetts, May 1, 1894.—Sky clear; wind moderate, from ESE.

Maj. Livermore and Mr. Luther heard the third-class Daboll trumpet, with 50-foot wooden extension, and also an 8-inch whistle situated halfway up the tower at Boston light and operated by compressed air, in all directions, out to a distance of 3 nautical miles. The test was not carried to any greater distance. There was no indication of a "ghost."

Boston Narrows, Massachusetts, May 11, 1893.—Maj. Livermore and Mr. Luther, from a point on the east side of Fort Warren, observed the audibility of bell A,

which was set up on the forward deck of the tender *Myrtle*, and struck a blow of about 100 foot pounds. The *Myrtle* ran 3 miles to the eastward of Fort Warren and returned, the sound being perfectly clear at the extreme distance. The wind was blowing at an angle of 45° against the sound, with a velocity of 8 knots. The bell at Boston Narrows, about one-third of a mile east of Fort Warren, was heard about three-fourths of a mile by the observers on the *Myrtle*.

Race Point light-station, Massachusetts, November 10, 1893 (*see* Chart XL).—The *Myrtle* was sent to this station to carry lumber, etc., and Mr. Wallace went with her to make observations on the audibility of the 10 and 12 inch steam fog whistles. He says:

"The *Myrtle* anchored off Race Point at 1:12 p. m., and I went ashore and requested the keeper to get up steam. In conversation with him it was learned that complaints had often been made by captains of vessels that the sound of the whistles was never heard far to windward, except it be in a northerly wind, when, according to the keeper, it is heard farther to windward than to leeward."

The steam pressure carried was about 50 pounds, requiring a consumption of 75 pounds of coal and 60 gallons of water per hour. The fall of pressure was 3 pounds to a blast of 4 seconds.

Capt. Samuel Fisher, of the Race Point life-saving station, said that in a strong SE. wind the seamen have the greatest difficulty in making the signal. He said:

"A sort of gap in the contour of the land runs from the whistle."

Race Point light-station, Massachusetts, November 11, 1893 (*see* Chart XL).—The wind was blowing from the NW. at the rate of 8 knots, hauling a little more northerly, and increasing to 11 knots by noon. Thermometer, 52° F.; barometer, 30.40; sea, smooth; sky, clear; sun, shining.

The signals began at 8 a. m. and the 10 and 12 inch whistles alternated in periods of 5 minutes each. At this time the *Myrtle* lay off Long Point light, landing materials. The observer could see the steam when the signal began to operate. The sound was faintly heard while the 12-inch whistle was blowing, increasing noticeably when the 10-inch whistle began. The *Myrtle* started at 8:10 a. m., running around Long Point light, hearing the sound, except for a moment, when the whistle was obscured by the land, until 8:30, when it suddenly stopped. As it did not begin again the steamer ran to the light. The keeper had mistaken another steamer for the *Myrtle*, and thinking the observer out of hearing of the signal had stopped it. It was again started, and the *Myrtle* ran SW.

The range varied from 1½ miles to the SW. across the wind to 2 miles to the WNW. against the wind, and to 3 miles NW. against the wind. The greatest range was to the north, 45° against the wind, where it was heard 3½ miles. On this day the range was very short across the wind, where the buildings probably had an influence. The sound represented on the chart is that of the 10-inch whistle, which was the louder in all directions.

In July, 1894, Maj. Livermore made observations on these whistles.

The wind was SSW., 5 knots. The *Myrtle* ran WNW., and at 6 miles the 10-inch whistle was faintly heard, while the 12-inch whistle was doubtful. At 6½ miles the 10-inch was still heard and the 12-inch was not. The 10-inch was lost at 6¾ miles. As both whistles were run alternately from the same boiler it is possible that the 12-inch whistle was not operated to best advantage.

REPORT OF MR. J. H. WALLACE ON THE NORTHEAST SNOWSTORM, AND ITS EFFECT ON THE PROPAGATION OF SOUND OF FOG SIGNALS.

The effect of a NE. wind, and especially a NE. snowstorm, on the propagation of sound was mentioned by Gen. Duane in his report of experiments made at Portland, Me., in 1871.* He says:

"The signal is often heard at a great distance in one direction, while in another it will be scarcely audible at a distance of a mile. This is not the effect of wind, as

* See Henry on Sound, p. 481.

the signal is frequently heard much farther against the wind than with it. For example, the whistle on Cape Elizabeth can always be distinctly heard in Portland, a distance of 9 miles, during a heavy NE. snowstorm, the wind blowing a gale directly from Portland toward the whistle."

We find that Gen. Duane's statement concurs with the observations of many of the light-keepers and fishermen along the coast. We find that men who have for years been in a position that would lead them to observe this question particularly are a unit in the opinion that a fog signal is best heard in a NE. snowstorm.

Mr. I. Grant, for many years keeper at Matinicus Rock and Whitehead light-stations, says:

"From Matinicus Rock I frequently heard the Monhegan signal, distant 20 miles W. by N., in a NE. snowstorm, and seldom at any other time." Also, "The plainest I ever heard the Monhegan signal from Whitehead was during a NE. snowstorm."

Mr. Grant inclosed two notes from his journal while at Whitehead light-station, Maine.

"September 16, 1875: Heard Matinicus fog signal distinctly. Wind light, NE., sky overcast, fog clearing.

"February 1, 1876: Heard Matinicus fog signal during the day. Snow had been falling during the day, with variable winds and calms, changing toward evening to fine rain, freezing as it fell, and terminating with a strong SW. gale and snow squall."

From the second note it would appear that the snowstorm itself had a good effect on sound propagation, with wind in other than NE. direction.

I am of the opinion that these impressions are gained from the fact that most snowstorms on this coast are from the NE., and that there are seldom occasions for running the signals in a NE. wind unaccompanied by snow, etc. All these observations of keepers seem to have been made from the NE. of the station, and because they heard the signal better in the NE. snowstorm than they had in other winds, that they concluded that it could be better heard against a NE. snowstorm than with it. Since there seems to be no record of the audibility of a signal to the SW. in a NE. snowstorm, there are no grounds on which to base the above conclusion.

Observations have been made, however, to the NE. and SW. of Whitehead light, in a high wind from the NE., accompanied by occasional heavy showers of rain, and it was found that in every instance the sound was better heard to the leeward than to windward of the station, while the appearance of rain was often accompanied by an increase in the sound of the signal. (*See* observations at Whitehead, September 28, 1893.)

While in some cases cited the sound would be rather across than against the wind, there are still a sufficient number to show that the sound is heard better to the NE. with a NE. snowstorm than with other winds. But there appears to be no proof that the improvement in audibility which accompanies the NE. wind does not exist in all directions.

To make observations to the SW. of the signals from the tender during a NE. storm would involve some danger, and it has not happened that observers have been in the vicinity at the right time to make them. That signals are heard better in a snowstorm agrees with the generally accepted theory that fog, rain, hail, and—most of all—snow by tending to increase the homogeneity of the atmosphere and to produce downward refraction because of the difference in temperature of the upper and lower strata, and thus to improve the audibility of signals.

Mr. Wallace took the opportunity of observing sound propagation in a NE. snowstorm, both to windward and to leeward. He says:

"I was fortunate enough to be able to make some observations at Worcester, Mass., during a NE. snowstorm on December 31, 1893. There was about an inch of snow on the ground, and snow was falling in very large flakes, with a fresh wind from the

NE., temperature 24° F. The signal was a small tin horn, 4 inches in length, blown by lung power. It was possible to produce a tone of nearly constant intensity by blowing it as hard as possible without producing an overtone.

"A wide boulevard was chosen running north and south, and quite free from disturbing elements, as houses, trees, etc. A test of the intensity to windward was first made, and the limit of audibility carefully marked. Stationing the signal at this point, I went to the first point of location of the signal, and found the horn was now plainly heard, and on retreating it was found that the audibility with the wind was one and one-third times that against the wind. The distances were: To windward, 880 yards; to leeward, 1,200 yards.

"Locating the signal at the summit of a hill in the vicinity, I went in a westerly direction, snow alone intervening between signal and observer, and found the limit of audibility to be 2,430 yards, the point being marked and measured on the following day. Beyond this point nothing could be heard of it.

"Suddenly the snow became thicker and finer, entirely obscuring objects at a distance of 100 feet. I returned to my station at 2,430 yards, and the sound of the signal was clear and loud. I then carried the sound to 3,000 yards distance in the same direction.

"Another change in the weather confirmed the result. The snow ceased and the sun came out suddenly. I hurriedly returned to 2,430 yards distance, hearing nothing, but all this time seeing the operator in the act of blowing the horn.

"Returning to the signal, nothing was heard at 1,320 yards, when the operator, seeing me returning rapidly, thought the observations were completed and stopped blowing. During all this second test the wind was light from the NE.

"On the next day, which was clear and fair, temperature 29° F., I found the range of the horn to be about two-fifths as great as on the preceding day."

On March 29, at Boston light-station, the effect of snow on sound was noticed. The *Clover*, with Mr. Adams and a party of observers, was at a point where no signals were heard. It was raining. Suddenly it began to snow, when the signal (bell C) was immediately heard. The bell was ringing all the time and with the same blow.

The effect was also noticed from the *Myrtle* by Maj. Livermore and other observers, but in this case the change was from a faint to a loud sound instead of from inaudibility to audibility.

On April 8, 1894, the *Clover* lay in Gloucester Harbor during a NE. snowstorm of considerable violence. The steam whistles at Thatcher Island were plainly heard during the day, the observation being from a point 5 miles SW. of the signal and behind the hills of Eastern Point.

This increase in audibility in a NE. wind is easily accounted for by temperature refraction.

The keeper of Pumpkin Island light-station hears Whitehead whistle a distance of 20 miles in a NE. snowstorm, and at no other time. The sound is coming directly against the wind, and it would seem that it must be refracted high above the observer in less than one-fifth this distance. This would be true if wind alone were acting. The NE. winds are colder than the usual temperature of the atmosphere, and as they blow along the surface of the earth they decrease the velocity of sound 1 foot per second for each degree difference of temperature. The NE. wind is often accompanied by a warmer wind above, as has been verified by trustworthy observations. A difference in wind velocities of 1 foot per second is rendered ineffectual by differences of temperature of 1° F. (*See* mathematical discussion.)

It is easy to see, then, that a NE. wind may not be potent enough to tilt the rays of sound above the observer against this powerful effect of differences in temperature. If accompanied by such homogeneous conditions as are liable to be present with rain or snow, the increased audibility is even more readily accounted for.

Conclusions.

BEST LOCATION FOR FOG SIGNALS.

The principles affecting the transmission of sound through the air have been discussed above and illustrated by many applications. It is hoped that this discussion will be of service in locating fog signals.

To state in a few words how fog signals should be placed would be no easy task. Some of the most prominent considerations may be mentioned, but the conditions are often conflicting, and it is not always possible to place the signal where it can best be heard.

It is better for a signal to be heard in unfavorable weather for 3 or 4 miles than to be heard occasionally for 20 or 30 miles. Its location should therefore be planned for unfavorable weather, when the wind is blowing from the sea or from the most dangerous approach, when the noise of the waves is high, etc.

It should be so placed as to face the dangerous approach, and no buildings, rocks, or trees should obstruct the passage of the sound. It is not enough that the signals should be visible from the water, for obstacles tend to break up the sound when they only approximate to the direct line it traverses.

Buildings and large rocks in the rear of stations may break up the sound to some extent; on the other hand, in some positions when they present a large and comparatively smooth surface to the signal they reenforce the sound by reflection. It is an advantage to have the ground in front of a signal slope gently toward the sea. Rocks and bushes in front of it break up the sound.

A signal on the top of a high cliff* should be as near the edge as possible, as the brink of the cliff not only obscures the sound near the foot, but will cut off or break up the descending ray, so that the sound can not travel against the wind. When the wind strikes a steep cliff it is deflected upward with greatly increased velocity, and all the injurious effects of refraction are exaggerated. These vertical winds are sometimes so strong that it is impossible to throw a comparatively heavy object over the brink, even when a few feet back the air is so calm as to be oppressive.

A smooth, gently sloping hill is a much better location than a rocky precipice, but even such a hill retards the lower stratum of an adverse wind, and this helps to tilt up the ray.

When the surface of the sea is smooth and the wind is not against the sound, a signal at the water's edge and in front of a vertical wall is well placed for throwing its sound in the direction it faces, but, as stated above, signals should be located with reference to unfavorable conditions, and an adverse wind would break up the surface of the sea and the wall would retard the wind at the surface and increase the upward refraction.

Of two positions, one directly over the other,* the higher would generally be preferable, and accordingly the French have made it a rule to put their sirens in the light-house towers. A few feet more or less in the elevation has but little effect at a great distance.

The ground around a signal acts not only in increasing refraction by retarding the lower strata of air, but also in heating or cooling the air above it and causing refraction and reflexion, and this influence should be considered.

Reflectors are useful not only in directing the sound where it is needed and where it will not be broken up, but in screening it from residences on shore where it is not appreciated. A reflector above a signal is very useful. Reflectors should be very large.

A signal on the top of a light-house rising directly out of the water, such as it is proposed to establish off Cape Hatteras, would be less affected by refraction than one on land.

*Pl. I.

Signals should be placed at salient points when practicable. A whistling buoy about a mile or two in front of a signal is a most valuable adjunct; not because a "silent area" has any definite existence, but because when the wind blows against the sound it diminishes in intensity at all distances, and it is more important for vessels near the shore to know their location than farther out. They can approach with confidence and expect to hear either the buoy or the signal. A wind that obscures the signal is in the proper direction to agitate the buoy, whereas if the buoy does not sound the signal should be heard. These buoys may go adrift or be run down by passing vessels, but they can readily be replaced if the light-keeper gives timely notice, and the danger is reduced to a minimum by this combination.

A light-ship with a fog signal has just been established at the entrance to Boston Harbor, north of Minots Ledge. This is an exceptionally good location, for the reason that its signals should be heard when that from the light-station is not. A vessel could hardly enter the harbor without hearing its signal either before or after passing it.

No general tests have been made this year of the fog signals on light-ships. It would appear, however, that so far as refraction by wind alone is concerned, a fog signal would be well placed if it were as far forward and as high as possible, so as to be strongest against the wind.

SUGGESTIONS TO MARINERS.

Mariners differ so widely in capacity that rules which would be very useful to one might be misleading to another. No definite instructions can be prepared that will insure against accidents. Even the best of seamen are often harassed by cares and duties that divert their attention for the moment, and in case of disaster the most conflicting accounts have been given of the aberrations of the audibility of fog signals.

The noises upon the ship, the noise of the wind and waves, and the condition of the nerves all affect the audibility of fog signals to a degree that can best be appreciated by studying the evidence. It is impossible to navigate in bad weather without more or less risk.

Mariners should study the principles that affect the audibility of fog signals, just as they study the art of navigation, and should notice the wind and temperature whenever they hear fog signals. They should only depend upon hearing them at short range, unless the wind and weather favor the sound, but if they do hear them at long range they should make what use they can of them.

They should remember that it does not require a very heavy wind to drive back the sound; that a southerly wind generally drives back the sound more than a northerly or an easterly one; that about the time of a change in the wind the sound is not generally heard as far as usual; that when the upper and lower currents of air run in different directions, or when the upper sails fill and the lower sails flap, or conversely, the signal is not to be depended upon; that a very heavy wind tends to break up all sound; that if a vessel is traveling with the wind the signal will probably be heard better than if it were traveling against it; that behind a hill or an island the signal may be heard better at a distance than nearer to the obstacle; they should bear in mind that it is hard to locate a feeble sound, and even a strong one may appear to come from the wrong direction if it is obstructed by objects near it, even by objects not directly in the straight line between the observer and the signal; that neighboring cliffs and sails sometimes reflect the sound; that the sound may be cut off entirely by passing vessels; that to estimate the direction of the sound the head should be turned rapidly from side to side, so that the sound may reach the ears alternately.

Table of

[EXPLANATION OF TABLE OF OBSERVATIONS.—*Direction of signal:* Indicates the direction in which in which the signal is impeded by trees, buildings, and other solid objects. *Distance:* Indicates the the signal. *Angle:* Refers to the angle made by the direction in which the sound is traveling to the sound be traveling to the observer against the wind, the angle is 0; if it be traveling across the wind,

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Libby Islands, Me.:				
June, 1892 [1]	10-inch whistle		S	N.
January 26, 1894 (XI).	....do		S	N.
Do	....do		S	N.
Do	....do		S	N.
Do	....do		S	N.
Petit Manan, Me.:				
June 2, 1893	Bell A (960 pounds) on Myrtle.	200 ft. lbs	S	N., E., and W.
Do	....do	....do	W	E., N., and S.
November 19, 1893 (XII). [2]	10-inch whistle	50 lbs	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	NW. by N. and SE. by S.	NE. by E. and SW. by W.
Do	10-inch whistle	50 lbs	E. to S	N. and NW.
Do	8-inch whistle on Myrtle.	35 lbs	NNW. and SSE	WSW. and ENE.
Do	....do	....do	N. and S	E. and W
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	ESE. and WNW	SSW. and NNE.
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	SSW. and NNE	ESE. and WNW.
November 20, 1893 (XII). [2]	....do	....do	NE. and SW	NW. and SE.
Do	Bell B on Myrtle		NE	SW
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	NW. and SE	SW. and NE
Do	Bell B on Myrtle		NW	SE.
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	Bell B on Myrtle		W	E
Do	8-inch whistle on Myrtle.	35 lbs	E. and W	N. and S
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	....do	....do		N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	ESE. and WNW	NNE. and SSW
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	NW. and SE	NE. and SW
Do	10-inch whistle	50 lbs	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	....do	....do	E. to S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	E. by S. and W. by N.	N. by E. and S. by W.
Do	....do	....do	ESE. and WNW	NNE. and SSW
Mount Desert Rock, Me.:				
November 21, 1893 (XLII). [2]	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	8 inch whistle on Myrtle.	35 lbs	NNW. and SSE	ENE. and WSW.
Do	Bell B (960 pounds) on Myrtle.	150 ft. lbs	SSE	NNW
Do	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	8-inch whistle on Myrtle.	35 lbs	NW. and SE	SW. and NE
Do	Bell B on Myrtle	150 ft. lbs	NW	SE.
Do	8-inch whistle on Myrtle.	35 lbs	ESE. and WNW	NNE. and SSW
Do	Bell B on Myrtle	150 ft. lbs	ESE	WNW

[1] Echo heard from N. end of Libby Islands.

[2] Running.

observations.

the signal at the station points, or is unobstructed. *Direction of obstruction:* Indicates the direction distance of the observer from the signal. *Direction:* Indicates the direction of the observer from observer, and the direction from which the wind is blowing, in points of the compass; i. e., if the it is 8 points; if it is traveling with the wind, it is 16 points.]

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
9.00 a. m.	None ...	1¼	N. by E...	....	Calm	....	....	....	Long swell	Thick fog.
8.49 a. m.	Limit...	0¾	N. by E...	12	ENE	11	7	....	....	Clear; mist near horizon.
8.55 a. m.	...do	1½	NE	....	ENE	2	....	....	....	Do.
9.10 a. m.	Plain ...	0¾	SE	....	ENE	6	....	....	....	Do.
9.55 a. m.	Limit...	8	WSW	....	ENE	16	....	....	....	Do.
....	Plain ...	4	S	....	SW	4	....	....	....	
....	...do	4	W	....	SW	4	....	....	....	
1.23 p. m.	Random	4	NE	2	WNW	10	40	30.07	Smooth ...	Clear.
1.29 p. m.	Limit...	3	NE	....	NNW	10	....	30.07	.....do	Do.
2.46 p. m.	...do	5¾	NE. by E .	2	NW	9	37	30.07	.....do	Do.
2.48 p. m.	...do	6	SW. by W.	....	NW	7	....	30.07	.....do	Do.
3.10 p. m.	Random.	5	ENE	....	N. by W ..	7	....	30.07	.....do	Do.
3.24 p. m.	Limit...	3¼	WSW	....	N.	10	....	30.07	.....do	Do.
3.40 p. m.	...do	3¾	W	....	N. by E...	9	....	30.07	.....do	Do.
3.48 p. m.	...do	5	E	2½	N. by E...	7	....	30.07	.....do	Do.
4.09 p. m.	Random.	5¾	WNW	....	N. by E...	7	....	30.07	.....do	Do.
4.30 p. m.	Limit...	4	ESE	....	N. by E...	9	....	30.97	.....do	Do.
4.30 p. m.	...do	4	WNW	....	N. by E...	7	....	30.07	.....do	Do.
9.34 a. m.	...do	3	NW	19	NNE	6	33	29.88	Rough; running 1 ft. high.	Cloudy; cirrus and cumulus.
9.34 a. m.	...do	3	NW	....	NNE	6	....	29.88	.....do	Do.
9.36 a. m.	...do	3¼	SE	....	NNE	10	....	29.88	.....do	Do.
9.53 a. m.	Plain ...	3¾	NW. by N	....	NNE	5	....	29.88	.....do	Do.
9.53 a. m.	...do	3¾	NW. by N	....	NNE	5	....	29.88	.....do	Do.
10.10 a. m.	Limit...	2¼	SSE	....	NNE	12	....	29.88	.....do	Do.
10.24 a. m.	...do	1½	N	19	NNE	2	37	29.87	.....do	Do.
10.31 a. m.	...do	2¼	N	....	NNE	2	....	29.87	.....do	Do.
10.46 a. m.	...do	4¾	S	....	NNE	14	....	29.87	.....do	Do.
10.13 a. m.	Random.	3¾	SSW	....	NNE	16	....	29.87	.....do	Do.
11.17 a. m.	Limit...	8	NNE	....	NNE	0	....	29.87	.....do	Do.
11.20 a. m.	Random.	2¼	SSW	....	NNE	16	....	29.87	.....do	Do.
11.30 a. m.	Limit...	1¾	SSW	....	NNE	16	34	29.87	.....do	Do.
11.55 a. m.	...do ...	2¼	SW	....	NNE	14	....	29.87	.....do	Do.
11.55 a. m.	...do	2½	NE	....	NNE	2	....	29.87	.....do	Do.
12.34 p. m.	Random.	2	WSW	....	NNE	12	36	29.88	.....do	Do.
12.39 p. m.	Limit...	1½	WSW	....	NNE	12	....	29.88	.....do	Do.
12.55 p. m.	...do	2¼	W	....	NNE	10	....	29.88	.....do	Do.
1.11 p. m.	Plain ...	3¾	E. by S ...	....	NNE	7	....	29.88	.....do	Do.
1.17 p. m.	...do	3¾	ESE	....	NNE	8	....	29.88	.....do	Do.
9.58 a. m.	Limit...	1½	W	7.3	W	0	32	30.11	Smooth ...	Cloudy.
10.20 a. m.	...do	3½	ENE	....	....	....	....	30.11	.....do	Do.
10.29 a. m.	...do	2	ENE	(3) (4)	SW .... E	....	....	30.11	.....do	Do.
10.53 a. m.	...do	1½	SW	....	....	....	40	30.19	.....do	Do.
11.06 a. m.	Faint...	3¼	NE	....	....	....	....	30.19	.....do	Do.
11.06 a. m.	...do	3¼	NE	....	....	....	....	30.19	.....do	Do.
11.17 a. m.	Limit...	3¾	NNE	....	....	....	....	30.19	.....do	Do.
11.21 a. m.	...do	3	NNE	....	....	....	....	30.19	.....do	Do.

[3] Lower current. [4] Upper current.

Table of observ

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Mount Desert Rock, Me—Continued.				
November 21, 1893 (XLII).[1]	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	do	do	SW	NE
Do	Bell B on Myrtle	150 ft. lbs	W	E
Do	8-inch whistle on Myrtle.	35 lbs	ENE. and WSW	NNW. and SSE
Do	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Do	8-inch whistle on Myrtle.	35 lbs	NE. and SW	SE. and NW
Do	do	do	SSW. and NNE	WNW. and ESE
Do	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Do	8-inch whistle on Myrtle.	35 lbs	N. and S	E. and W
Do	do	do	NW. and SE	SW. and NE
Do	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	do	do	SW	NE
Do	8-inch whistle on Myrtle.	35 lbs	NW. and SE	NE and SW
Do	do	do	E. and W	S. and N
Do	Bell B on Myrtle	150 ft. lbs	W	E
Do	Third-class Daboll trumpet.	5 lbs	W	E
Do	do	do	W	E
Do	8-inch whistle on Myrtle.	35 lbs	ENE. and WSW	NNW. and SSE
Do	Bell B on Myrtle	150 ft. lbs	ENE	WSW
Do	Third-class Daboll trumpet.	5 lbs	SW	NE
Do	do	do	SW	NE
Do	do	do	SW	NE
Great Duck Island, Me.:				
June 1, 1894	10-inch steam whistle		S	N
Deer Island Thoroughfare, Me.:				
June 2, 1894 (XXXVIII).	Fog bell		W	E
Do	do	do	W	E
Goose Rocks, Me.:				
June 2, 1894 (XXXVIII).	do	9 ft. lbs	S	N. and E
Do	do	do	S	N. and E
Do	do	do	S	N. and E
Do	do	do	S	N. and E
Matinicus Rock, Me.:				
September 27, 1893[1]	Bell B on Myrtle	80 ft. lbs	ESE	WNW
Do	do	do	WNW	ESE
Matinicus Rock, Me.:				
May 31, 1894	10-inch steam whistle		SW	NE
Bear Island, Me.:				
June 1, 1894	Fog bell			
Whitehead, Me.:				
September 8, 1893 (XIV).	10-inch whistle	45 lbs	S	N. and NW
Do.[1]	do	do	S	N. and NW
September 9, 1893 (XV).[1]	do	do	S	N. and NW
Do.[1]	do	do	S	N. and NW
Do.[4]	Bell A, 960 pounds	178 ft. lbs	N	E., S., and W
Do	10-inch whistle	45 lbs	S	N. and NW
Do.[5]	do	do	S	N. and NW

[1] Running. [2] Moderate. [3] Light.

tions—Continued.

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg.*	*Deg.*	*Inches.*		
11.34 a. m.	Limit...	1	SSW......	5	S........	2	39	30.17	Smooth...	Cloudy.
12.24 p. m.	...do....	1¼	S........	6	SSE......	2	....	30.17	.....do....	Do.
12.34 p. m.	Plain...	2¾	N........	....	SSE......	14	....	30.17	.....do....	Do.
12.39 p. m.	...do....	2¾	NNW....	....	SSE......	16	....	30.17	.....do....	Do.
12.53 p. m.	Limit...	0¾	SSE......	6	SSE......	0	41	30.15	Slight chop	Light snow.
1.01 p. m.	...do....	0⅝	SE........	....	Shifting..	....	41	30.15	.....do....	Do.
1.03 p. m.	Silent...	0¾	SE........	....	.....do....	....	....	30.15	.....do....	Do.
1.05 p. m.	Random	1	SE........	....	.....do....	....	....	30.15	.....do....	Do.
1.07 p. m.	Silent...	1¼	SE........	....	.....do....	....	....	30.15	.....do....	Do.
1.09 p. m.	Random	1⅛	SE........	....	.....do....	....	....	30.15	.....do....	Snowing.
1.11 p. m.	Limit...	1¾	NW......	....	.....do....	....	....	30.15	.....do....	Do.
1.38 p. m.	Plain...	1⅛	WNW....	....	.....do....	....	....	30.15	.....do....	Do.
1.45 p. m.	Random	0½	ESE......	....	.....do....	....	42	30.13	.....do....	Do.
1.48 p. m.	Limit...	0½	ESE......	....	.....do....	....	....	30.13	.....do....	Do.
2.04 p. m.	...do....	1⅛	E........	9	NW......	12	43	30.12	.....do....	Do.
2.11 p. m.	...do....	2½	W........	....	NW......	4	....	30.12	.....do....	Do.
2.30 p. m.	...do....	1⅜	SW. by W.	....	....	....	....	30.12	.....do....	Do.
2.39 p. m.	...do....	0¼	NE......	17	SSW....	14	....	30.12	.....do....	Clear; cirrus clouds to E. and NE.
2.50 p. m.	...do....	1½	NE. by N.	17	SW......	15	....	30.12	.....do....	Do.
2.57 p. m.	...do....	2¼	SW. by S.	....	SW......	1	....	30.12	.....do....	Do.
3.07 p. m.	Plain...	1	S........	....	SW. by W.	5	....	30.12	.....do....	Do.
3.17 p. m.	...do....	1	S........	....	SW. by W.	5	....	30.12	.....do....	Do.
3.20 p. m.	Limit...	0⅞	N........	....	SW. by W.	11	42	30.10	.....do....	Do.
3.29 p. m.	...do....	1¼	NNW....	....	WSW....	8	41	30.10	.....do....	Do.
3.30 p. m.	Faint...	1¾	SSE......	....	WSW....	8	....	30.10	.....do....	Do.
3.39 p. m.	...do....	1⅜	SSE......	....	WSW....	8	....	30.10	.....do....	Do.
4.02 p. m.	Limit...	1	NW......	....	WSW....	6	....	30.10	Wave heights, 1 foot.	Do.
4.20 p. m.	...do....	1¼	WNW....	16	W. by S..	3	40	30.09	.....do....	Do.
4.47 p. m.	...do....	0¾	SW......	....	W. by S..	3	....	30.09	.....do....	Do.
....	Heard..	4	NNE.....	(4)	SW......	14	....	....	....	
....	Limit...	0¼	SSW.....	2	SSW.....	0	68	29.21	....	
....	...do....	3½	N........		SSW.....	14	....	29.21	....	
....	...do....	0¾	W........	10	SW......	4	....	....	....	
....	...do....	1	W........	5	SW......	4	....	....	....	
....	...do....	2	SE........	10	SW......	8	....	....	....	
....	...do....	2	NE......	....	SW......	16	....	....	....	
4.30 p. m.	...do....	0⅞	SSW.....	(5)	ENE......	12	....	....	....	Pleasant.
4.50 p. m.	...do....	3	SSW.....	....	ENE......	12	....	....	....	Do.
....	...do....	4½	NNE.....	....	SW......	14	....	....	....	
....	...do....	1½	ENE.....	....	SW......	14	....	....	....	
5.55 p. m.	Faint...	3½	SW. by W	6	WNW....	5	53	29.98	Running high.	Cloudy.
6.30 p. m.	Limit...	3½	NE......	6	WNW....	10	....	29.98	....	
7.06 a. m.	Faint...	7	NE......	9	WSW....	14	69	31.03	Smooth...	Clear.
7.36 a. m.	Plain...	5	NE......	10	WNW....	10	....	31.03	.....do....	Do.
9.55 a. m.	Limit...	2¼	NE......	10	WNW....	10	....	31.03	.....do....	Do.
10.13 a. m.	...do....	3¾	NE......	....	WNW....	10	....	31.03	.....do....	Do.
11.29 a. m.	Random	5	NE. by E.	....	W........	13	....	31.03	.....do....	Do.

[4] On Clover, N. side of Whitehead.

[5] Fisherman Island Passage.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Whitehead, Me.—Continued.				
September 9, 1893 (XV).	10-inch whistle	45 lbs	S	N. and NW
Do[1]	....do	....do	S	N. and NW
Do	Bell A	178 ft. lbs	N	E., S., and W
Do	10-inch whistle	45 lbs	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do[2]	Bell A	178 ft. lbs	N	N. and NW
September 28, 1893 (XVI).	10-inch whistle	45 lbs	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do[3]	....do	....do	S	N. and NW
Do	....do	....do	S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	SE. and NW	NE. and SW
Do	10-inch whistle	45 lbs	S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	SE. and NW	NE. and SW
Do	Bell B on Myrtle	150 ft. lbs	NW	SE
Do	10-inch whistle	45 lbs	S	N. and NW
Do	....do	....do	S	N. and NW
Do	2,000-pound bell	tremendous	E	W
Do	10-inch whistle	45 lbs	S	N. and NW
Do	8-inch whistle on Myrtle.	35 lbs	SE. and NW	NE. and SW
Do	....do	....do	SE. and NW	NE. and SW
Do	2,000-pound bell		E	W
June 13, 1894	10-inch whistle	45 lbs	S	N. and NW
June 19, 1894	....do	....do	S	N. and NW
Do	....do			
June 21, 1894 (XVII).	....do	45 pounds	S	
Do	....do			
Do	....do			
Owls Head, Me.:				
September 7, 1893 (XVIII).	Fog bell, 1,200 pounds		SE	W
Do[4]	Bell A	178 ft. lbs	E	W
Do[5]	....do	....do	W	E
Do	Fog bell, 1,200 pounds		SE	W
Do	....do		SE	W
Do	....do		SE	W
Do	....do		SE	W
Do[4]	Bell A	178 ft. lbs	E	W
Do[4]	....do	....do	E	W
Do	Fog bell		SE	W
Do	....do		SE	W
Do	Bell A	178 ft. lbs	E	W

[1] Near Two-Bush Island. [2] On Clover, SW. of Whitehead. [3] In Seal Harbor, behind hills.

tions—Continued.

Time of day.	Audibility.	Distance	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
11.50 a. m.	Limit...	4¼	E........	......	WNW....	14	....	31.03	Smooth ...	Clear.
12.15 p. m.	Plain...	2¼	SE	9	WSW	10	....	31.03	.....do	Do.
12.15 p. m.	Random	2¼	SE	......	WSW	10	....	31.03	.....do	Do.
12.40 p. m.	Silent...	2	WSW	......	SW. by W.	1	....	31.03	.....do	Do.
12.44 p. m.	...do	2¼	W. by S...	9	SW. by W.	2	....	31.03	.....do	Do.
12.50 p. m.	Faint ...	2¾	WSW	9	WSW	0	....	31.03	.....do	Do.
2.26 p. m.	Silent...	1	SW	15	SW	0	....	31.03	.....do	Cirrus clouds in NE.
3.15 p. m.	...do	1⅝	SW	......	SW	0	....	31.03	.....do	
3.30 p. m.	...do	2	SW	11	SW	0	....	31.03	.....do	Cirrus stratus in W.
3.37 p. m.	...do	3¼	SW	......	SW	0	....	31.03	.....do	
3.41 p. m.	Limit ...	4	SW	......	SW	0	....	31.03	.....do	Do.
3.56 p. m.	Random	5¼	SW	......	SW	0	....	31.03	.....do	Do.
4.13 p. m.	Limit ...	5	SW	......	SW	0	....	31.03	.....do	Do.
4.46 p. m.	Silent ..	2¼	SW. by S..	......	SW. by S..	0	....	31.03	.....do	Do.
4.56 p. m.	Random	1	SW. by S..	12	SW. by S..	0	....	31.03	.....do	Do.
5.01 p. m.	Silent ..	0¾	SW. by S..	15	SW	1	....	31.03	.....do	Do.
....	Faint ...	2¾	SW	11	SW	0	....	31.03	.....do	Do.
7.36 a. m.	Random	3¾	NE	12	NNE	2	....	30.13	Waves 1 foot high.	Showery, air damp and disagreeable.
7.44 a. m.	Limit ...	3½	NE	......	NNE	2	....	30.13	.....do	Do.
8.00 a. m.	Silent...	2	NE	......	NNE	2	....	30.13	.....do	Do.
8.20 a. m.	...do	0¾	NE	......	NNE	2	....	30.13	.....do	
9.06 a. m.	...do	0¾	NE	......	NNE	2	....	30.13	.....do	
9.16 a. m.	...do	1¾	NE	......	NNE	2	....	30.13	.....do	Commenced raining.
9.23 a. m.	Plain ...	0¾	NE	......	NNE	2	....	30.13	.....do	Raining.
9.32 a. m.	Silent...	0¾	N	......	NNE	2	....	30.13	.....do	Do.
12.09 p. m.	Limit ...	1½	NE	23	NNE	2	49	30.13	Rough	Do.
2.00 p. m.	Random	6¾	SW	......	NNE	14	50	30.13	.....do	Heavy mist.
3.04 p. m.	...do	4¼	NE	17	NNE	2	....	30.13	.....do	Do.
3.04 p. m.	...do	4¼	SW	......	NNE	14	....	30.13	.....do	Do.
3.08-p. m.	...do	3¾	SW	......	NNE	14	....	30.13	.....do	Do.
3.30 p. m.	...do	1¾	NE	22	NNE	2	....	30.13	.....do	Do.
3.28 p. m.	Limit ...	0¾	NE	......	NNE	2	....	30.13	.....do	Do.
4.10 p. m.	Faint ...	2¼	SSW	20	N	14	....	30.13	.....do	Do.
4.22 p. m.	...do	3¾	SW	20	N	12	....	30.13	.....do	Do.
4.25 p. m.	...do	3¼	NE	......	N	4	....	30.13	.....do	Do.
4.30 p. m.	Plain	2¾	NE	......	N	4	....	30.13	.....do	Do.
4.35 p. m.	Faint ...	2¼	SW	......	N	12	....	30.13	.....do	Do.
9.30 a. m.	Plain ...	4¾	NE	3	SE	8	56	30.36	Smooth ...	Clear.
7.40 a. m.	Faint ...	8	NE	1	SW	16	....	....	.....do	Foggy and clear, alternating.
9.00 a. m.	...do	7½	NE	......	SW	16	....	....	....	Do.
12.25 p. m.	Plain ...	7½	NE	4	SW	16	53	30.16	Smooth...	Slight fog.
3.00 p. m.	Limit ...	10	SW	......	Calm	....	58	30.19	.....do	Dense fog.
3.33 p. m.	Random	10½	SW	2	SE	8	....	30.19	.....do	Do.
11.16 a. m.	Limit...	2½	SE	6	SW	8	....	30.2	Choppy...	Raining.
11.25 a. m.	...do	2¾	SE	......	SW	8	59	30.2	.....do	Do.
12.10 p. m.	...do	1½	SE	6	S	4	....	30.2	.....do	Do.
12.16 p. m.	...do	0¾	SE	......	S	4	....	30.2	.....do	Do.
2.21 p. m.	...do	1¾	NNE	9	ESE	8	....	30.2	.....do	Do.
2.33 p. m.	...do	1	NNE	......	ESE	8	....	30.2	.....do	Do.
2.50 p. m.	. .do	1	SE	4	SSE	2	....	30.2	.....do	Raining hard.
3.05 p. m.	...do	2	SE	......	SSE	2	....	30.2	.....do	Do.
3.09 p. m.	...do	2	SE	......	SSE	2	....	30.2	.....do	Do.
3.13 p. m.	...do	1½	SE	......	SSE	2	....	30.2	.....do	Do.
3.47 p. m.	...do	3	E	10	S	8	....	30.2	.....do	Rain and hazy.
3.52 p. m.	Faint ...	3½	E	......	S	8	....	30.2	.....do	Do.

[4] On Clover. [5] Clover turned with tide.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Owls Head, Me.—Continued.				
September, 7, 1893 (XVIII.)	Fog bell		SE	W
Do	....do		SE	W
Do	Bell A	178 ft. lbs	E	W
Do	....do	....do	E	W
Do	Fog bell		SE	W
Do	....do		SE	W
Do	Bell A	178 ft. lbs	E	W
Do	Fog bell		SE	W
Do	....do		SE	W
Do	....do		SE	W
Do	Bell A	178 ft. lbs	E	W
Do	Fog bell		SE	W
September 8, 1893 (XIX).	Fog bell, 1,200 pounds		SE	W
Do [1]	Bell A	178 ft. lbs	E	W
Do	....do	....do	E	W
Do	Fog bell		SE	W
Do	Bell A	178 ft. lbs	E	W
Do	....do	....do	E	W
Do	....do	....do	E	W
Do	....do	....do	E	W
Do	....do	....do	E	W
Do	Fog bell		SE	W
Do	....do		SE	W
Do	....do		SE	W
Do	Bell A	178 ft. lbs	E	W
Do	....do	....do	E	W
Do	Fog bell		SE	W
June 13, 1894 (XX).	Fog bell, 1,200 pounds		SE	W
Do	....do		SE	W
June 14, 1894 (XX).	....do		SE	W
June 19, 1894	....do		SE	W
Penobscot Bay, Me.:				
June 14, 1894 (XXI). [2]	8-inch whistle on Myrtle.	35 lbs	E. and W	N. and S
Do	....do		SE. and NW	SW. and NE
Do	....do	....do	SE. and NW	SW. and NE
Do	....do	....do	E. and W	N. and S
Do [2]	....do	....do	E. and W	N. and S
Manana Island, Me.:				
June 21, 1894 (XXII).	First-class Daboll trumpet.	5 lbs	W	NE. and S
Do	....do			
Cuckolds fog signal, Me.:				
November 16, 1893 [2]	Third-class Daboll trumpet.	4 lbs	E. by N	W
June 21, 1894 [2] (XXIII).	....do	....do	E. by N	W
June 22, 1894	....do			
Pond Island, Me.:				
September 14, 15, and 17, 1893. [2]	Fog bell		E	W
Seguin, Me.:				
September 14, 1893 (XXIV). [2]	10-inch whistle	50 lbs	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N
Do	....do	....do	W	N

[1] On Clover. [2] Running.

tions—Continued.

3.54 p. m.	Random	3¼	E		S	8		30.2	Choppy	Rain and hazy.
4.08 to 4.12 p. m.	...do	3¼	ESE		S	6		30.2	...do	Do.
4.08 to 4.14 p. m.	...do	3¼	ESE		S	6		30.2	...do	Do.
4.20 p. m.	...do	3½	SE. by E		S	5		30.2	...do	Do.
4.20 p. m.	...do	3½	SE. by E		S	5	60	30.01	...do	Do.
4.25 p. m.	...do	3¾	SE		S	4		30.01	...do	Do.
4.27 to 4.30 p. m.	...do	3¼	SE		S	4		30.01	...do	Do.
4.35 p. m.	...do	2¼	SSE		S	2		30.01	...do	Do.
4.56 p. m.	...do	2¼	S		S	0		30.01	...do	Foggy.
5.03 p. m.	...do	2¾	SSW		S	2		30.01	...do	Do.
5.16 p. m.	Limit	0¼	SSW		S	2		30.01	...do	Do.
5.17 p. m.	...do	0¼	SSW		S	2		30.01	...do	Do.
10.00 a. m.	...do	0¼	NNE	16	NNW	4	50	29.84	Choppy; waves 5 feet high.	Cloudy.
10.16 a. m.	Random	1	NE		NNW	6		29.84	...do	Do.
10.50 a. m.	...do	2	SE		NNW	14		29.84	...do	Do.
10.50 a. m.	...do	2	SE		NNW	14		29.84	...do	Do.
11.00 a. m.	...do	2¼	SE	18	NNW	14		28.84	...do	Do.
11.15 a. m.	...do	2¾	SSE		NNW	16		29.84	...do	Do.
11.37 a. m.	...do	2¾	S	20	NNW	14		29.84	...do	Do.
11.55 a. m.	...do	2¼	SSW	17	NNW	12		29.84	...do	Do.
12.05 p. m.	Limit	1¼	SSW	16	NNW	12		29.84	...do	Do.
12.08 p. m.	Random	1	SW. by S		NNW	11		29.84	...do	Do.
12.11 p. m.	Limit	0¼	SSW		NNW	12		29.84	...do	Do.
12.30 p. m.	...do	0¼	NE		NNW	6		29.84	...do	Do.
12.34 p. m.	...do	0¼	N		NNW	2		29.84	...do	Do.
12.38 p. m.	Random	6	NW		NNW	2		29.84	...do	Do.
12.46 p. m.	Limit	0¼	NNW	16	NNW	0		29.84	...do	Do.
3.11 p. m.	...do	0¼	NW	5	SE	16	60	30.36	Smooth	Clear.
3.45 p. m.	Plain	1	SSE		S	2		30.36	...do	Do.
5.07 p. m.	Limit	3¼	NNE	3	SSE	12			...do	Do.
9.00 a. m.	Plain	0¼	SW		Calm				...do	Dense fog.
9.31 a. m.	Faint	6¼	NNE		...do		64	30.50	...do	Hazy.
12.10 p. m.	...do	4¼	NW		...do			30.50	...do	Do.
12.45 p. m.	...do	5	NW		...do			30.50	...do	Do.
1.14 p. m.	Plain	2¼	W		...do			30.50	...do	Do.
1.14 p. m.	Faint	6	N		...do			30.50	...do	Do.
8.00 p. m.	Limit	0¼	NE	4	S. by E	11	55	30.2	Smooth	Heavy fog.
9.30 p. m.	...do	0¼	W. by S		Baffling, NE. and SE.		53	30.34	...do	Hazy.
1.53 p. m.	Limit	2¾	ENE	27	WNW	8	39	29.64	Rough; heavy swell.	Clear; blue, corona clouds N. and E.
9.10 p. m.	Limit	9¼	SE		(ᵃ)		56	30.25	Smooth	Hazy
3.40 a. m.	...do	7¾	SW					30.25	...do	Do.
	...do	0¼	S		SW	4			Rough	
12.38 p. m.	...do	1¾	N	16	SSW	14	61	30.20	...do	Clear.
1.18 p. m.	Random	1¾	N		SSW	14		30.20	...do	Do.
1.24 p. m.	Limit	1¼	N. by E		SSW	15		30.30	...do	Do.
1.47 p. m.	Silent	6¼	S. by W		SSW	1		30.20	...do	Do.
1.55 p. m.	Random	1¼	S		SSW	2		30.20	...do	Do.
2.07 p. m.	...do	2	S. by E		SSW	3		30.20	...do	Do.
2.23 p. m.	Silent	2¾	S. by E		SSW	3		30.20	...do	Do.
2.43 p. m.	Limit	5¼	S. by E		SSW	3		30.20	...do	Do.
3.15 p. m.	Random	5	SSW		SSW	0		30.20	...do	Lowering.
3.27 p. m.	Limit	[illegible]	SSW		SSW	0		30.20	...do	Do.

ᵃ Observed from top of Mount Megunticook.

ᵃ Very light, SE. then NE.

Table of observ

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Seguin, Me.—Cont'd.				
September 14, 1893 (XXIV).	10-inch whistle	50 lbs	W	N
Do	do	do	W	N
September 15, 1893 (XXIV).	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
September 17, 1893 (XXV).	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
Do	do	do	W	N
September 14, 1893 (XXIV).	8-inch whistle on Myrtle.	35 lbs	E. and W	N. and S
Do	Bell A	178 ft. lbs	E. by S	NW. and S
Do	do	do	E. by S	NW. and S
September 15, 1893 (XXIV).	do	do	E. by S	NW. and S
Do	8-inch whistle on Myrtle.	35 lbs	E. by S	NW. and S
September 17, 1893 (XXV).	do	do	E. by S	NW. and S
May 30, 1894	10-inch whistle	50 lbs	W	N
June 22, 1894 (XXVI).[1]	do	do	W	N
Do	do	do	W	N
Halfway Rock, Me.:				
June 12, 1894 (XX)	Fog bell		SW	NE
Do	do		SW	NE
Do	do		SW	NE
Do	do		SW	NE
Cape Elizabeth, Me.:				
May 24, 1873	Bell A on Myrtle		N. by W	
Do	do		S	
September 11, 1893 (XIV).	Second-class siren	55 lbs	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	do	do	S	N
September 12, 1893 (XXVII-XXVIII)	do	55 lbs	S	N
Do	do	do	S	N
Do[2]	do	do	S	N
Do	do	do	S	N
Do	12-inch whistle	do	S	N
Do	8-inch whistle, on Myrtle.	35 lbs	N. by E	W. by N. and E. by S
Do	Bell A, Myrtle	178 ft. lbs	N. by E	W. by N. and E. by S
Do	12-inch whistle	55 lbs	S	N
Do	do	do	S	N
Do	Second-class siren	do	S	N
Do	12-inch whistle	do	S	
Do	8-inch whistle, on Myrtle.	35 lbs	NNE	WNW. and ESE
Do	Bell A, Myrtle	178 ft. lbs	NNE	WNW. and ESE
Do	do	do	NNE	WNW. and ESE
Do[4]	do	do	E	N. and S
Do[4]	12-inch whistle	55 lbs	S	N
Do	do	do	S	N
Do	do	do	S	N
Do	Second-class siren	do	S	N
Do	8-inch whistle on Myrtle.	35 lbs	SSW. and NNE	ESE. and WNW
Do	Bell A, on Myrtle	178 ft. lbs	SSW	NNE
Do	Second-class siren	55 lbs	S	N

[1] Running.

[2] Behind Richmond Island, heard between 11.50 and 12 noon.

tions—Continued.

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
3.38 p. m.	Silent...	3½	SSW	....	SSW......	0	....	30.20	Rough	Lowering.
4.40 p. m.	...do	1½	W. by S ..	....	....	....	....	....	....	
7.15 a. m.	Random	0¾	W. by S ..	18	SE........	11	61	30.14	Waves 3 ft.	Heavy mist.
7.31 a. m.	...do	0¾	S	....	SE........	4	....	30.14	.....do	Do.
7.38 a. m.	Silent...	1½	SE........	....	SE........	0	....	30.14	.....do	Do.
7.43 a. m.	Limit...	1⅛	SE. by S..	....	SE........	1	....	30.14	.....do	Do.
7.50 a. m.	Random	1½	S. by E ...	....	SE........	3	....	30.14	.....do	Do.
8.51 a. m.	Limit...	0½	WNW.....	....	SE........	14	....	30.14	.....do	Do.
9.15 a. m.	...do	0¾	NNW	....	SE........	14	31	31.3	.....do	Commenced raining.
8.49 a. m.	...do	0¾	SW.......	25	SSW......	2	....	30.1	.....do	Clear.
9.51 a. m.	...do	1	W	....	SSW......	4	....	30.1	Rough	Do.
10.15 a. m.	...do	1⅝	WNW.....	....	SSW......	8	....	30.1	.....do	Do.
10.55 a. m.	...do	1⅝	N. by W..	....	SSW......	18	....	30.1	.....do	Do.
1.55 p. m.	Faint...	3½	N.........	16	SSW......	14	61	30.20	.....do	
4.46 p. m.	Limit...	1½	NNE	....	SSW......	16	....	30.20	.....do	
....	....	....	....	....	....	....	....	30.20	.....do	
....	Faint ...	2½	N.........	18	SE	12	....	30.20	.....do	Misty, rainy.
7.48 a. m.	...do	3½	N.........	....	SE........	12	....	30.20	.....do	Do.
8.25 a. m.	Plain ...	2½	N. by E...	25	SSW......	15	....	30.1	.....do	Clear.
....	Limit...	1½	WNW....	10	ESE	16	....	....	....	Raining.
3.20 a. m.	...do	3½	SSE	2	NNE	12	59	30.34	Smooth ...	Foggy.
10.20 a. m.	Faint...	7½	WSW	3	SSW......	4	69	30.24	.....do	Clearing.
....	Limit...	0¼	E.........	3	ESE	2	67	30.08	....	Cloudy.
....	...do	0½	SE........	....	....	....	....	30.08	....	Do.
....	...do	5¾	W	....	....	....	....	30.08	....	Do.
....	Faint ...	2	W	....	....	....	....	30.08	....	Do.
....	Plain ...	2	N. by W ..	8	SW.......	11	....	....	....	Clear.
....	Faint ...	¾	N. by W ..	8	SW.......	11	....	....	....	Do.
11.23 a. m.	Random	4	N.........	4	SE........	12	....	30.3	Wave height, 3 inches.	Do.
11.30 a. m.	...do	3¾	NNE	....	SE........	10	....	30.3	.....do	Do.
12.07 p. m.	Limit...	1¾	NE	....	SSE	10	....	30.3	.....do	Do.
12.25 p. m.	...do	1	NNE	....	S. by E....	13	....	30.3	.....do	Do.
2.36 p. m.	Random	2¼	NE	....	SW.......	16	....	30.3	.....do	Do.
2.39 p. m.	Limit...	1⅝	NE	10	SW.......	16	....	30.3	.....do	Do.
3.28 p. m.	Plain ...	2½	S	....	SW.......	4	....	30.3	.....do	Do.
4.38 p. m.	Limit...	2¾	NNE	....	SW.......	14	61	30.3	.....do	Do.
8.45 a. m.	Random	5	NNE	6	NE	2	....	30.40	Smooth ...	Clear; bright.
8.59 a. m.	Limit...	4½	NE. by N .	6	NE	1	....	30.40	.....do	Do.
11.19 a. m.	...do	2¾	SW. by W.	....	(³)	....	....	30.40	.....do	Do.
11.50 a. m.	Random	2¾	W. by S...	....	(³)	....	....	30.40	.....do	Do.
12 m.	...do	3½	W. by S...	....	(³)	....	....	30.40	.....do	Do.
12 m.	Faint...	3½	E. by N ...	....	(³)	....	65	30.40	.....do	Do.
12 m.	Plain ...	3½	E. by N ...	....	(³)	....	....	30.40	.....do	Do.
12.07 p. m.	Random	4	W. by S...	....	(³)	....	....	30.40	.....do	Do.
12.43 p. m.	Limit...	3½	SW. by W.	2	SE........	9	....	30.40	.....do	Do.
1.53 p. m.	...do	2¾	NE. by N .	5	SSW	15	....	30.40	.....do	Do.
2 p. m.	...do	3¾	NNE	....	SSW	16	....	30.40	.....do	Do.
2 p. m.	...do	3¾	SSW	....	SSW	0	....	30.40	.....do	Do.
2 p. m.	...do	3⅝	SSW	....	SSW	6	....	30.40	.....do	Do.
2 p. m.	Plain ...	3½	NW	....	SSW	10	....	30.40	.....do	Do.
....	Faint...	6	NNW	....	SSW	12	....	30.40	.....do	Do.
3.12 p. m.	Random	5	N. by E ...	....	SSW	15	....	30.40	.....do	Do.
3.17 p. m.	...do	4¾	NNE	....	SSW	16	....	30.40	.....do	Do.
3.27 p. m.	Limit...	4¾	NE. by N .	5	SSW	15	65	30.37	.....do	Clear.
3.31 p. m.	...do	4½	NE. by N .	....	SSW	15	....	30.37	.....do	Do.
3.06 p. m.	Random	5½	S. by W...	5	SSW	1	....	30.37	.....do	Do.
3.06 p. m.	Limit...	5½	S. by W...	....	SSW	1	....	30.37	.....do	Do.
4.11 p. m.	Faint...	5¾	E.........	....	SW. by W..	13	....	30.37	.....do	Do.

[3] Varying rapidly. [4] Observer at Portland.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Cape Elizabeth, Me.—Continued.				
September 12, 1893 (XXVII-XXVIII).	12-inch whistle	55 lbs	S	N.
Do	Bell A on Myrtle	178 ft. lbs	NW	SE.
Do	12-inch whistle	55 lbs	S	N.
Do	Second-class siren	do	S	N.
Do	do	do	S	N.
Do	do	do	S	N.
Do	12-inch whistle	do	S	N.
September 25, 1893 (XXIX).	do	55 lbs	S	N.
Do	do	do	S	N.
Do	do	do	S	N.
Do	Second-class siren	do	S	N.
Do	do	do	S	N.
September 26, 1893 (XXIX).	12-inch whistle	55 lbs	S	N.
Portland Head, Me.:				
September 4, 1893 (XXX).	Bell A	178 ft. lbs	S	N.
Do	Third-class Daboll trumpet.	4½ lbs	E	W
Do	do	do	E	W
Do	Bell A	178 ft. lbs	S	N
Boon Island, Me.:				
September 23, 1893.	Fog bell			
Whaleback, N. H.:				
September 23, 1893 (XXV).	Third-class Daboll trumpet.		SE.	
Do	do			
Do	1,500-pound bell on Myrtle.	80 ft. lbs	SW	NE
Do	8-inch whistle, Myrtle.	35 lbs	SE. and NW	NE. and SW
Cape Ann, Mass:				
November 14, 1893 (XXXI).[1]	10-inch whistle	40 lbs	E	W
April 5, 1894 (XXXII).[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	Two 10-inch whistles	do	E	W
Do[1]	10-inch whistle	do	E	W
Do[1]	do	do	E	W
April 6, 1894 (XXXIII).[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1 2]	do	do	E	W
Do[1 2]	do	do	E	W
Do[1]	do	do	E	W
April 7, 1894 (XXXIV).[1 2]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	do	do	E	W
Do[1]	do	do	E	W
Eastern Point, Mass:				
May 4, 1894 (XXXV).[1]	Fog bell, 2,000 pounds.	Light	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
May 5, 1894 (XXXV).[1]	do	do	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
Do[1 4]	do	do	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
Do[1]	do	do	E., S., or W	N. and NE
Baker Island, Mass.:				
September 22, 1893.	Fog bell			

[1] Running. [2] Heard between.

tions—Continued.

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
4.09 p. m.	Plain ...	5¾	E	....	SW. by W.	13	....	30.37	Smooth ...	Clear.
4.15 p. m.	Faint...	5½	W. by N...	....	SW. by S..	6	....	30.37	....do	Do.
5 p. m.	Silent...	2	S	5	SW	4	....	30.37	....do	Do.
5 p. m.	...do	2	S	....	SW	4	....	30.37	....do	Do.
5.52 p. m.	...do	0½	SSW	....	SW	2	....	30.37	....do	Do.
6.10 p. m.	Limit...	2¼	NE	....	SW	16	....	30.37	....do	Do.
6.10 p. m.	...do	2½	NE	....	SW	16'	....	30.37	....do	Do.
1.10 p. m.	...do	3¾	NNE	23	S	14	....	....	....	
1.20 p. m.	Silent...	2¾	NE	....	S	12	....	....	....	
1.30 p. m.	...do	1¾	NE	....	S	12	....	....	....	
3.25 p. m.	Limit...	1¾	S. by W...	....	S. by E....	2	....	....	....	
4.05 p. m.	...do	4	N.........	10	S. by E....	15	....	....	....	
11.47 a. m.	...do	6¼	ENE	4	SW	14	....	30.33	....	
3.10 p. m.	...do	6	S. by E....	6	SW	5	....	29.9	....do	Do.
3.37 p. m.	...do	8	S. by E....	....	SW	5	....	29.9	....do	Do.
4.50 p. m.	...do	4	S. by E....	9	W. by S...	8	....	29.9	....do	Do.
4.57 p. m.	...do	3	S. by E....	....	W. by S...	8	....	29.9	....do	Do.
6.15 p. m.	Limit...	1½	WSW	3	SSW	5	....	....	....	Cloudy.
4.35 p. m.	...do	6	E. by S ...	3	SSW	9	....	....	....	Do.
6.35 p. m.	...do	6½	E	....	SSW	10	....	....	....	Do.
4.35 p. m.	...do	6	W. by N ..	....	SSW	7	....	....	....	Do.
4.55 p. m.	...do	7½	E. by S ...	....	SSW	9	....	....	....	Do.
3.09 p. m.	...do	6	NE. by N .	5	NE	1	52	30.1	Smooth ...	Clear.
12.30 p. m.	Plain ...	5¼	S. by E....	....	W. by S...	8	49	29.77	Choppy...	Cloudy.
2.04 p. m.	Limit...	7½	ENE	6	W. by S...	15	47	29.77	....do	Do.
3.26 p. m.	...do	6¾	NE	12	W. by N ..	11	45	29.81	....do	Dull and overcast.
3.36 p. m.	...do	5½	NE	....	W. by N ..	11	46	29.83	....do	Do.
4.50 p. m.	...do	3¾	S. by W...	....	W. by N ..	6	45	29.77	....do	Do.
9.10 a. m.	...do	10½	SW	8	NNW	10	40	29.88	Smooth ...	Light rain.
9.22 a. m.	Random.	10½	SW	....	NNW	10	....	....	....do	Do.
9.26 a. m.	...do	9¾	SW	....	NNW	10	....	....	....do	Do.
9.29 a. m.	...do	9½	SW	....	NNW	10	40	29.92	Choppy...	Light hail.
9.17 a. m.	...do	7¾	SW. by S .	7	NNW	11	40	29.90	....do	Raining hard.
10.08 a. m.	...do	6¾	SSW	....	NNW	12	....	....	....do	Do.
10.37 a. m.	...do	6¼	S. by W...	10	N.........	15	38	29.93	Rough	Rain and sleet.
11.50 a. m.	Faint...	6	NE. by E .	3	SW	15	44	30.12	Smooth ...	Clear.
12.06 p. m.	...do	4	NE. by N .	....	SW	15	44	30.13	....do	Do.
12.52 p. m.	Random.	3½	N. by W ..	10	S	15	45	30.15	....do	Do.
2.36 p. m.	...do	4¼	N. by E...	8	SSE	13	40	30.10	....do	Do.
3.11 p. m.	Limit...	4¼	NE. by N .	....	SSE	11	40	30.10	....do	Do.
10.02 a. m.	...do	0½	SE........	2	SE........	....	47	30.22	....do	Cloudy.
11.14 a. m.	...do	1	SSE	3	SSE	....	49	30.23	....do	Overcast.
3.07 p. m.	...do	2¾	SW. by W	2	SE. by E..	10	49	30.21	....do	Cloudy.
10.06 a. m.	...do	1½	W. by S...	4	S. by E ...	8	52	30.12	....do	Mist clearing.
11.02 a. m.	Silent...	1	SSE	3	S. by E ...	1	54	30.08	....do	Mist.
11.28 a. m.	...do	1	SSE	....	S. by E ...	1	54	30.08	....do	Clear.
12.14 p. m.	Loud ...	1	SSE	3	S. by E ...	1	56	30.10	....do	Do.
1.22 p. m.	Limit...	2½	SSE	5	SE........	2	53	30.08	....do	Do.
1.33 p. m.	Random.	3	S. by W ..	5	SE........	5	53	30.08	....do	Do.
....	Limit...	2¼	ENE	3	SSW	12	....	....	....do	Do.

[3] Lost; obstructed by buildings.

[4] Light hidden by mist clear to horizon.

Table of observ

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Minots Ledge, Mass.:				
May 3, 8, and 9, 1894 (XXXVI).[1]	Fog bell	10 ft. lbs	ESE	WNW
Do[1]	Bell B	75 ft. lbs	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1,2]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
Do[1]	do	do	S. by E.	N. and NE
May 10, 1894 (XXXVII).[1]	do	do	ESE	NE
Do[1]	do	do	ESE	NE
Do[1]	do	do	ESE	NE
Do[1]	do	150 ft. lbs	ESE	NE
Do[1]	do	do	ESE	NE
Do[1]	do	do	ESE	NE
Do[1]	do	do	ESE	NE
May 11, 1894 (XXXVII).[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[1,2]	do	do	ESE	NE
Do[4]	do	do	ESE	NE
Do[4]	do	do	ESE	NE
Do[4]	do	do	ESE	NE
Do[4]	do	do	ESE	NE
May 12, 1894 (XXXVIII).	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Do	do	do	ESE	NE
Boston Light, Mass:				
October 30, 1893 (XXXIX)[4].	First-class siren	55 lbs	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[1,2]	do	do	E. by S.	W
Do[1,2]	do	do	E. by S.	W
Do[5]	do	do	E. by S.	W
Do	do	do	E. by S.	W
Do	do	do	E. by S.	W
October 31, 1893 (XL)[4].	do	do	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[4]	do	do	E. by S.	W
Do[1,2]	do	do	E. by S.	W
Do[5]	do	do	E. by S.	W
Do[5]	do	do	E. by S.	W
Do[5]	do	do	E. by S.	W
Do[5]	do	do	E. by S.	W
January 23, 1894 (XLI).	Bell C, 4,000 pounds	350 ft. lbs	E	W
Do	Bell B, 1,040 pounds	148 ft. lbs	E	W
Do	do	do	E	W
Do	Bell C	350 ft. lbs	E	W
Do	Bell B	148 ft. lbs	E	W
Do	do	do	E	W

[1] Running. [2] Bell may not have been ringing until 8.24.

tions—Continued.

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
4.10 p. m.	Limit...	1	NE	8	SE. by S ..	9	51	30.14	Smooth ...	Clear.
3.39 p. m.	...do	5	E.........	2.	SE........	4	65	29.79	.....do	Do.
4.40 p. m.	Random.	5½	E.........	......	SE........	4	68	29.81	.....do	Do.
4.57 p. m.	Limit...	4¾	E. by N ...	3	SE........	5	62	29.81	.....do	Do.
8.24 a. m.	...do	0¾	N.........	10	NW	4	59	29.96	.....do	Do.
10.26 a. m.	...do	4¾	SSE	9	NW	14	60	29.97	.....do	Do.
11.14 a. m.	Random.	4	SE.........	......	NW	16	60	29.97	.....do	Do.
11.20 a. m.	Limit...	3¾	SE.........	7	NW. by N	15	58	30	.....do	Do.
3.35 p. m.	...do	4½	NNE	8	SE........	10	57	30.01	.....do	Do.
4.07 p. m.	Random.	4	N.........	6	SE........	12	57	30.01	.....do	Do.
4.17 p. m.	...do	3½	N. by W ..	......	SE........	13	57	30.01	.....do	Do.
4.39 p. m.	Limit...	2	NNW	10	SE........	14	57	30.01	.....do	Do.
8.46 a. m.	...do	0¾	N.by W ..	9	NE	5	53	30.28	Choppy...	Clear and cloudless.
10.03 a. m.	...do	1½	E. by S....	9	NE. by E .	4	58	30.26	.....do	Do.
11.25 a. m.	...do	1	N. by W ..	9	NE	5	54	30.26	.....do	Do.
1.17 p. m.	...do	1¼	NE	12	ESE	6	53	30.28	.....do	Do.
3.05 p. m.	...do	0¾	ESE	11	SE........	2	51	30.30	.....do	Do.
3.49 p. m.	...do	3	N. by W ..	12	SE........	13	....	30.30	.....do	Do.
4.32 p. m.	...do	2½	N. by W ..	10	SE........	13	50	30.30	.....do	Do.
11.53 a. m.	...do	1	N.........	20	SSE	14	54	30.16	Choppy wave heights 4 feet.	Fair; hazy in horizon.
2.52 p. m.	...do	1½	NW.by N.	13	WSW	7	57	30.28	.....do	Threatening.
3.17 p. m.	...do	0½	NNW	13	SW........	10	....	30.28	.....do	Do.
4.01 p. m.	...do	4	NE. by E .	13	SW........	15	58	30.26	.....do	Do.
4.38 p. m.	Random	3½	NE. by E .	12	SW........	15	53	30.25	.....do	Clearer.
4.47 p. m.	...do	3	NE	12	SW........	16	....	30.25	Smooth ...	Do.
4.52 p. m.	...do	3	NE. by N .	12	SW........	15	53	30.25	.....do	Cloudy.
2.14 p. m.	Limit...	0½	NW	18	S. by W ..	11	....	30.23	.....do	Do.
2.40 p. m.	...do	0¾	NE	18	S. by W ..	13	....	30.23	.....do	Do.
2.54 p. m.	...do	0¾	NE	18	S. by W ..	13	....	30.22	.....do	Do.
3.42 p. m.	...do	0¾	NNW	8	SSW......	12	....	30.32	.....do	Do.
9.14 a. m.	Random	1¾	NNW	......	N.........	2	60	30.31	.....do	Clear.
9.23 a. m.	Limit...	1½	NNW	2	N.........	2	....	30.31	.....do	Do.
10.19 a. m.	Faint...	2¾	WNW.....	......	N.........	6	....	30.31	.....do	Do.
10.53 a. m.	Limit...	3	N. by E...	7	E. by S ...	8	58	30.32	.....do	Do.
11.12 a. m.	...do	2½	NE	7	E. by S ...	5	....	30.32	.....do	Do.
12.02 p. m.	...do	3½	SE.........	7	ESE.......	2	....	30.32	.....do	Do,
12.10 p. m.	Random	3½	SE.........	7	ESE.......	2	....	30.32	.....do	Do.
12.18 p. m,	Limit...	3½	SE.........	7	ESE.......	2	....	30.32	.....do	Do.
4.16 p. m.	...do	11¾	E..........	......	W	16	....	30.25	.....do	Clear; clouds at horizon.
4.36 p. m.	...do	10¾	E. by S....	......	W	15	....	30.25	.....do	Do.
3.16 p. m.	Plain ...	9½	SE. by E..	8	W	13	....	30.25	.....do	Do.
2.23 p. m.	...do	6½	SE.........	......	W	12	....	30.25	.....do	Do.
3.33 p. m.	Faint...	6¾	SE.........	8	W	12	....	30.25	.....do	Do.
4.10 p. m.	Limit...	10½	SE. by S ..	12	W	11	....	30.25	.....do	Do.
4.35 p. m.	...do	11½	SE.........	......	W	12	....	30.25	.....do	Do.
12.00 m.	...do	2½	E..........	24	NNE	6	....	30.46	Choppy...	Clear.
12.35 p. m.	...do	4½	E. by N...	......	....	....	....	30.46	.....do	Do.
12.45 p. m.	...do	3½	NE	......	....	....	....	30.46	.....do	Do.
3.17 p. m.	...do	2½	N.........	......	....	....	....	30.46	.....do	Do.
4.01 p. m.	Plain ...	2¾	NNE	......	....	....	....	30.46	.....do	Do.
4.11 p. m.	Limit...	2½	NE. by N .	......	....	....	....	30.46	.....do	Do.
12.50 p. m.	Faint...	5	E..........	......	....	....	....	30.46	.....do	Do.
11.00 a. m.	Limit...	5½	SE. by E..	......	....	....	....	30.46	.....do	Do.
11.37 a. m.	...do	5¾	ESE	20	NNE	....	39	30.46	Choppy	Do.
1.30 p. m.	Faint...	3½	NE	......	....	....	....	30.46	Ground roll	Do.
12.00 m.	Limit...	1½	W	......	....	....	....	30.46	.....do	Do.
12.33 p. m.	Silent...	2	ESE	1	ENE	4	36	30.44	Smooth ...	About ½ cumulus clouds.
12.33 p. m.	...do	2	ESE	......	ENE	4	....	30.44	.....do	Do.
2.00 p. m.	Limit...	8½	ESE	......	E.........	2	....	30.44	.....do	Do.
2.00 p. m.	...do	8¾	ESE	......	E.........	2	....	30.44	.....do	Do.
2.18 p. m.	Random	9½	ESE	......	E.........	2	....	30.44	.....do	Do.
2.25 p. m.	...do	10	ESE	......	E.........	2	....	30.44	.....do	Do.

[3] Observers on *Clover*. [4] *Myrtle*. [5] *Geranium*.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Boston Light, Mass.—Continued.				
January 23, 1894 (XLI).	Bell C	350 ft. lbs	E	W
Do	do	do	E	W
Do	do	do	E	W
Do	Bell B	148 ft. lbs	E	W
Do	Bell C	350 ft. lbs	E	W
Do	do	do	E	W
Do	Bell B	148 ft. lbs	E	W
January 31, 1894	First-class siren	55 lbs	E. by S	W
Do	do	do	E. by S	W
Do	do	do	E. by S	W
Do	Bell C, 4,000 pounds	350 ft. lbs	E	W
Do	do	do	E	W
February 7, 1894 (XLIII).	Bell B, 1,040 pounds	148 ft. lbs	E	W
Do	Bell C, 4,000 pounds	350 ft. lbs	E	W
Do	do	do	E	W
Do	Bell B	148 ft. lbs	E	W
Do	do	do	E	W
Do	Bell C	350 ft. lbs	E	W
Do	do	do	E	W
Do	Bell B	148 ft. lbs	E	W
February 28, 1894 (XLIV).	First-class siren	55 lbs	E. by S	W
Do	do	do	E. by S	W
Do [1]	do	do	E. by S	W
Do [1]	do	do	E. by S	W
Do	do	do	E. by S	W
Do	do	do	E. by S	W
March 22, 1894 (XLIV).	Bell C, 4,000 pounds	350 ft. lbs	E	W
Do	do	do	E	W
Do	do	do	E	W
Do	do	do	E	W
Do	do	do	E	W
Do	Tugboat whistle			
March 24, 1894 (XLV). [2]	Bell C, 4,000 pounds	350 ft. lbs	E	W
Do	Lyle gun, 3-inch bore.	2-lb. charge.	NE	S. and W
Do	do	do	NE	S. and W
Do	do	do	NE	S. and W
Do	Bell C	350 ft. lbs	E	W
Do	Lyle gun	2-lb. charge.	NE	S. and W
Do [3]	Bell C	350 ft. lbs	E	W
Do [3]	Lyle gun	2-lb. charge	NE	S. and W
Do	do	do	NE	S. and W
Do	do	do	NE	S. and W
Do	Bell C	350 ft. lbs	E	W
March 29, 1894 (XLV.) [4]	8-inch whistle, top of tower.	20 lbs. air	E	W
Do [4]	do	do	E	W
Do [5]	do	do	E	W
Do [5]	do	do	E	W
Do [6]	10-inch whistle	15 lbs. air	E	W
Do [6]	Air siren	do	E. by S	W
Do [6]	Steam siren	22 lbs. air	E. by S	W
Do [6]	do	18 lbs. air	E. by S	W
Do [6]	Bell C	350 ft. lbs	E. by S	W
Do [6]	do	do	E. by S	W
Do [5]	do	do	E. by S	W
Do [7]	do	do	E. by S	W
Do	do	do	E. by S	W
Do	do	do	E. by S	W
Do	do	do	E. by S	W

[1] Sound shadow. [2] Running. [3] Harding Ledge. [4] Rapidly colder.

tions—Continued.

Time of day.	Audibility	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
2.30 p.m.	Random	11	ESE	2	SE.........	2	....	30.44	Smooth	About ¼ cumulous cl'ds.
2.41 p.m.	...do	11½	ESE	....	SE.........	2	39	30.43	.....do	Do.
4.16 p.m.	Silent between	3	ESE	5	SE.........	2	....	30.43	.....do	Do.
4.16 p.m.	...do	3	ESE	....	SE.........	2	....	30.43	.....do	Do.
4.25 p.m.	Random	2	ESE	....	SE.........	2	....	30.43	.....do	Do.
4.37 p.m.	Silent between	1	ESE	6	SE.........	2	33	30.52	.....do	Do.
4.37 p.m.	...do	1	ESE	....	SE.........	2	....	30.52	.....do	Do.
2.51 p.m.	Limit...	1	W	16	WNW....	2	40	29.89	Slight swell	Clear.
3.15 p.m.	...do	0¾	W. by S...	....	NNW	7	....	29.89	.....do	Do.
3.40 p.m.	Plain ...	2	E. by S....	18	WNW....	15	38	29.92	.....do	Do.
3.10 p.m.	Limit...	0½	W	....	WNW....	2	....	29.92	.....do	Do.
3.40 p.m.	Plain ...	2	E. by S....	....	WNW....	15	....	29.92	.....do	Do.
1.28 p.m.	Silent between	3½	SE. by E..	16	WSW	11	40	30.10	Smooth ...	Cloudy.
1.30 p.m.	...do	3¾	SE. by E..	....	WSW	11	....	30.10	.....do	Do.
1.49 p.m.	...do	5½	SE. by E..	....	WSW	11	....	30.10	.....do	Do.
1.49 p.m.	...do	5½	SE. by E..	....	WSW	11	....	30.10	.....do	Do.
2.00 p.m.	Faint...	6¾	SE. by E..	14	WSW	11	....	30.10	.....do	Do.
2.00 p.m.	...do	6¾	SE. by E..	....	WSW	11	....	30.10	.....do	Do.
4.06 p.m.	...do	7½	ESE	15	WSW	12	....	30.10	.....do	Do.
4.08 p.m.	...do	7½	ESE	....	WSW	12	....	30.10	.....do	Do.
2.23 p.m.	Limit...	0¾	SSW	12	S. by W...	1	33	30.42	.....do	Clear.
2.32 p.m.	Random	1	SSW......	....	S. by W...	1	....	30.42	.....do	Do.
2.47 p.m.	Silent...	0¾	SSE	....	S. by W...	3	....	30.42	.....do	Do.
2.48 p.m.	Loud ...	0¾	SSE	....	S. by W...	3	....	30.42	.....do	Do.
3.00 p.m.	...do	2¼	SE.........	....	S. by W...	5	....	30.42	.....do	Do.
3.10 p.m.	...do	2	E	....	....	....	....	30.42	.....do	Do.
2.28 p.m.	Silent between	0¾	E. by S....	....	E.........	1	46	30.10	.....do	Cloudless.
3.02 p.m.	...do	1½	E. by S....	9	E.........	1	....	30.10	.....do	Do.
3.24 p.m.	Faint...	4¾	ESE	8	E.........	2	....	30.10	.....do	Do.
4.00 p.m.	Silent between	3	ESE	....	E.........	2	....	30.10	.....do	Do.
4.39 p.m.	...do	1½	E. by S....	....	E.........	1	....	30.10	.....do	Do.
4.25 p.m.	Plain ...	3	E	....	E.........	0	....	30.10	.....do	Do.
2.55 p.m.	Silent...	1½	ESE	12	E.........	2	....	....	.....do	Stars shining brightly, light air or clouds.
2.49 p.m.	Plain ...	1	ESE	....	E.........	1	....	....	.....do	Do.
3.21 p.m.	Faint...	4½	E. by S....	....	E.........	1	40	....	.....do	Do.
3.41 p.m.	Plain ...	5½	ESE	....	E. by S....	1	....	....	.....do	Do.
4.10 p.m.	Limit...	6¾	ESE	20	SE.........	2	....	....	.....do	Do.
4.25 p.m.	Silent...	6½	ESE	....	SE. by S..	3	(4)	....	.....do	Do.
4.42 p.m.	Limit...	6	SE. by E..	23	SSE	3	(4)	....	.....do	Do.
5.04 p.m.	Silent between	2¼	SE.........	17	SSE	2	(4)	....	Choppy...	Do.
5.06 p.m.	Silent...	2½	SE.........	....	SSE	2	(4)	....	.....do	Do.
5.26 p.m.	...do	1	SE.........	....	SSE	2	(4)	....	.....do	Do.
5.34 p.m.	Silent between	0½	SE.........	17	SSE	2	(4)	....	.....do	Do.
2.08 p.m.	Faint...	6	SE.........	16	SSW......	6	38	30.11	Rough	Raining.
2.08 p.m.	...do	3½	SE. by E..	16	SSW......	7	....	30.11	.....do	Do.
2.12 p.m.	Silent...	4	SE. by E..	16	SSW......	7	....	30.11	.....do	Cloudy and rain.
2.12 p.m.	...do	6½	SE. by E..	16	SSW......	7	....	30.11	.....do	Do.
3.31 p.m.	Faint...	6	SE. by E..	15	SW. by S.	8	....	30.11	.....do	Do.
2.24 p.m.	...do	6	SE. by E..	16	SSW......	7	38	30.08	.....do	Do.
2.20 p.m.	...do	6¼	ESE	16	SSW......	8	....	30.08	.....do	Do.
3.12 p.m.	...do	7½	ESE	15	SW. by S.	9	....	30.08	.....do	Do.
3.04 p.m.	Limit...	6½	SE. by E..	15	SW. by S.	8	....	30.08	.....do	Do.
3.27 p.m.	...do	6¾	ESE	15	SW. by S.	9	....	30.07	.....do	Do.
2.38 p.m.	...do	5	SE. by E..	15	SW. by S.	8	38	30.07	.....do	Do.
2.54 p.m.	Silent...	3¾	SE.........	16	SW.......	8	38	30.06	.....do	Do.
3.11 p.m.	...do	2¾	SE. by S..	15	SW. by S.	6	37	30.05	.....do	Do.
3.34 p.m.	...do	2¾	SE. by E..	15	SW. by S.	8	....	30.05	.....do	Raining.
3.49 p.m.	...do	1½	SE.........	15	SW. by S.	7	36	30.02	.....do	Commenced to snow.

[5] Clover, running. [6] Myrtle. [7] Clover.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Boston Light, Mass.—Continued.				
April 24, 1894 (XLV[1].)	First-class siren	55 lbs	E. by S	W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S.	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
April 25, 1894 (XLVIII).[1]	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
April 26, 1894 (XLIX).[1]	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	do	do	ESE	SW. and W
April 27, 1894 (L).[2]	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
April 28, 1894 (XLIX).[1]	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do	do	do	ESE	SW. and W
Do[4]	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do[5]	do	do	ESE	SW. and W
Do	Bell C	350 ft. lbs.	E. by S	W
Do	Trumpet with 50 feet extended.	6 lbs	E. by S	W
Do[6]	do	do	E. by S	W
Do	do	do	E. by S	W
May 1, 1894	do	do	ESE	SW. and W
Do	8-inch whistle half-way up tower.	12 lbs.	ESE	SW. and W
Do	Bell C	350 ft. lbs	E. by S	W
Do	do	do	E. by S	W

[1] Clover, running. [2] Myrtle. [3] Light baffling. [4] At Minots Ledge, Myrtle.

tions—Continued.

Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg.*	*Deg.*	*Inches.*		
8.00 a.m.	Plain	1½	E	Perfectly calm				29.89	Very smooth.	Thick fog.
11.39 a.m.	Faint	3½	E	do			50	29.89	do	Slight haze.
1.45 p.m.	Plain	1	ESE	do				29.89	do	Clearing.
1.45 p.m.	do	1	ESE	do				29.89	do	Do.
2.02 p.m.	do	2	NE. by E	do			51	29.88	do	Do.
2.02 p.m.	Faint	2	NE. by E	do				29.88	do	Do.
2.20 p.m.	Plain	2¾	ESE	do				29.88	do	Do.
2.20 p.m.	do	2¾	ESE	do				29.88	do	Do.
2.29 p.m.	do	3¾	SE	do			51	29.88	do	Do.
2.29 p.m.	Faint	3¾	SE	do				29.88	do	Clouding.
2.45 p.m.	Plain	3⅛	ESE	do				29.88	do	Do.
2.45 p.m.	do	3⅛	ESE	do				29.88	do	Do.
3.02 p.m.	do	2	SSE	do			48	29.88	Smooth	Do.
3.02 p.m.	Faint	2	SSE	do				29.88	do	Do.
12.38 p.m.	do	1	SW	5	SE	8	46	30.12	Gentle roll	Clear and cloudless.
12.38 p.m.	Loud	1	SW		SE	8		30.12	do	Do.
2.02 p.m.	do	0¾	S	9	SE	4	47	30.06	do	Cloudless.
2.02 p.m.	Faint	0¾	S		SE	4		30.06	do	Do.
3.20 p.m.	Plain	2	SE	9	SSE	2	47	30.05	do	Do.
3.20 p.m.	do	2	SE		SSE	2		30.05	do	Do.
4.00 p.m.	Silent	5⅛	ESE	8	SSE	4	47	29.99	do	Do.
4.00 p.m.	Faint	5⅛	ESE		SSE	4		29.99	do	Do.
4.25 p.m.	Plain	5¼	SE		SSE	2	47	30.02	do	Clear.
4.25 p.m.	Random	5¼	SE	8	SSE	2		30.02	do	Do.
12.45 p.m.	Plain	0¾	ESE	8	SW	10	67	30.00	Smooth	Do.
2.37 p.m.	Limit	9	ESE	7	SSE	4	56	30.00	do	Do.
2.42 p.m.	do	9	ESE		SSE	4		30.00	do	Do.
9.54 a.m.	Plain	6¾	SE. by S		(5)			30.02	Very smooth.	Do.
9.54 a.m.	do	6¾	SE. by S		(5)			30.02	do	Do.
11.55 a.m.	do	5⅛	ESE	3	NNE	8	70	30.02	do	Do.
11.55 a.m.	do	5½	ESE		NNE	8		30.02	do	Do.
2.10 p.m.	Faint	7⅛	SE. by E					30.02	do	Do.
2.10 p.m.	Limit	7⅛	SE. by E					30.02	do	Do.
2.42 p.m.	Faint	7⅛	ESE	5	ESE	0	69	29.98	do	Do.
3.08 p.m.	Limit	5½	SE. by E	20	SW	9		30.02	do	Do.
3.08 p.m.	do	5¼	SE. by E		SW	9	68	29.98	do	Do.
2.45 p.m.	Faint	1½	SE. by S	10	W	11	65	29.92	Very smooth.	Hazy.
2.45 p.m.	Plain	1½	SE. by S		W	11		29.92	do	Do.
11.24 a.m.	do	5	E	8	WSW	14		30.01	do	Light haze.
12.07 p.m.	Faint	6	SE	10	W	12	65	29.97	do	Hazy.
12.11 p.m.	Silent	5⅛	SE		W	12		29.97	do	Do.
12.14 p.m.	Faint	5¼	SE		W	12		29.97	do	Do.
1.05 p.m.	Plain	3	SSE		W	10		29.97	do	Do.
12.15 p.m.	do	6¾	SE. by S	10	W	11		29.97	do	Do.
12.15 p.m.	Faint	6¾	SE. by S		W	11		29.97	do	Do.
12.47 p.m.	do	5⅛	E. by N		W	15		29.97	do	Do.
12.47 p.m.	Plain	5⅛	E. by N		W	15		29.97	do	Do.
1.13 p.m.	Loud	2⅛	SE. by S	5	SW	7		29.97	do	Do.
1.13 p.m.	do	2⅛	SE. by S		SW	7		29.97	do	Do.
1.40 p.m.	do	2¼	E. by S	5	W. by N	16		29.97	do	Do.
2.12 p.m.	Plain	6¾	SE. by S	3	SW	7	70	29.90	do	Do.
3.00 p.m.	do	8	E. by S		SW	11		29.90	do	Do.
	Heard	3	NE. to SE.	(7)	ESE					Clear.
	do	3	NE. to SE.							Do.
	Limit	¾	SE		SE					Do.
	do	3	N. by W		N. by W					Do.

[5] Harding Ledge. [6] At Minots Ledge. [7] Moderate.

Table of observa

Station.	Character of signal.	Pressure or blows.	Direction of signal.	Direction of obstruction.
Boston Light, Mass.—Continued.				
May 11, 1894 (LI).[1]	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do[2]	Bell C (cracked)	175 ft. lbs	E. by S	W
Do[2]	Trumpet with 50 feet extended.	6 lbs	ESE	SW. and W
Do	Bell C	175 ft. lbs	E. by S	W
Boston Narrows, Mass.:				
May 11, 1893	Fog bell	Light	S	N
Do	Bell A, on Myrtle	100 ft. lbs	S	E. and W
Race Point, Mass.:				
November 10, 1893.	10-inch whistle	50 lbs	N	
Do	do	do	N	
November 11, 1893 (XL).	do	do	N	
Do	do	do	N	
Do	do	do	N	
Do	do	do	N	
Do	do	do	N	
Do	do	do	N	
Do	do	do	N	
Do	do	do	N	
July 20, 1894	do	do	N	
Do	12-inch whistle	do	N	
Do	10-inch whistle	do	N	
Do	do	do	N	

[1] Clover, running.

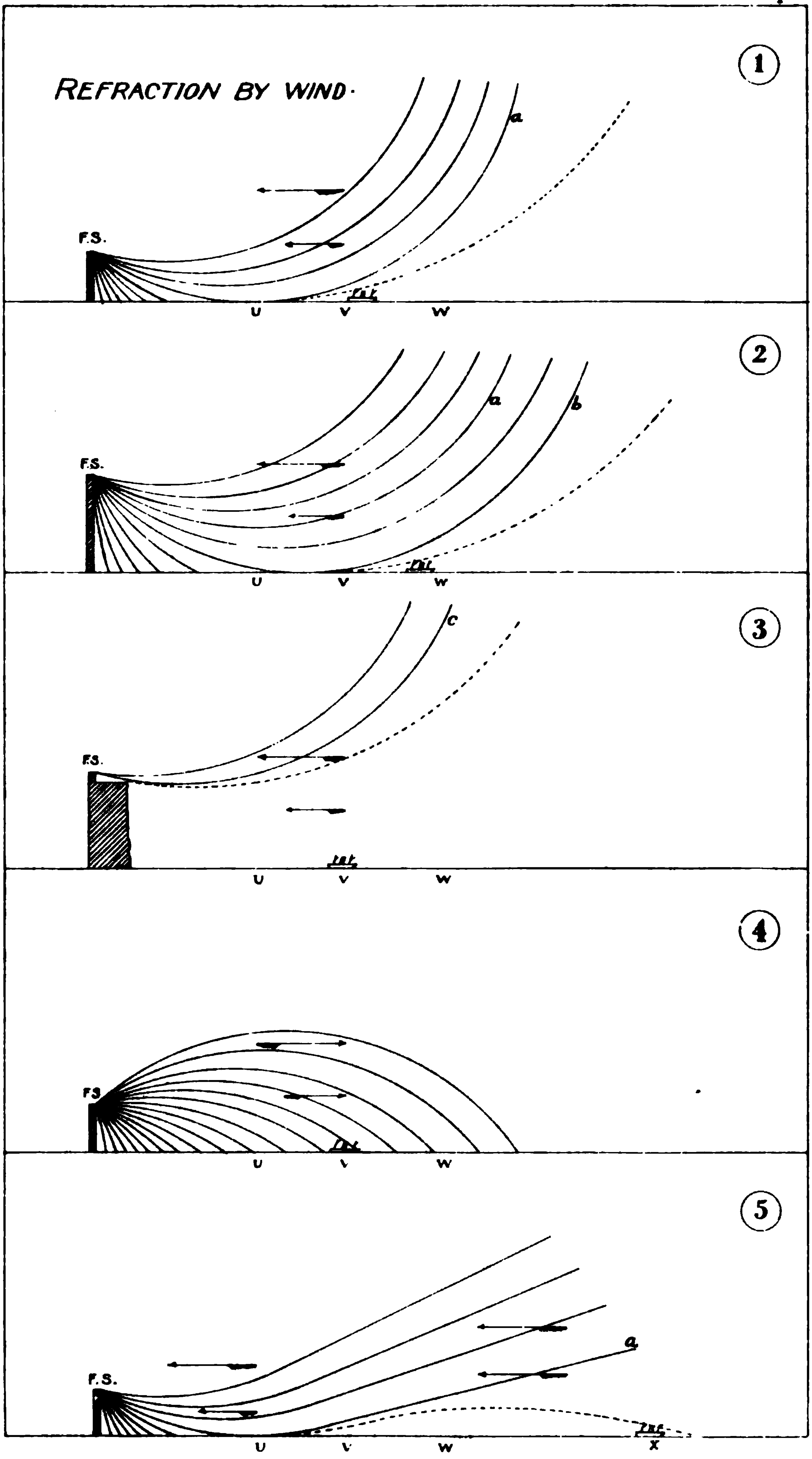
[2] Myrtle.

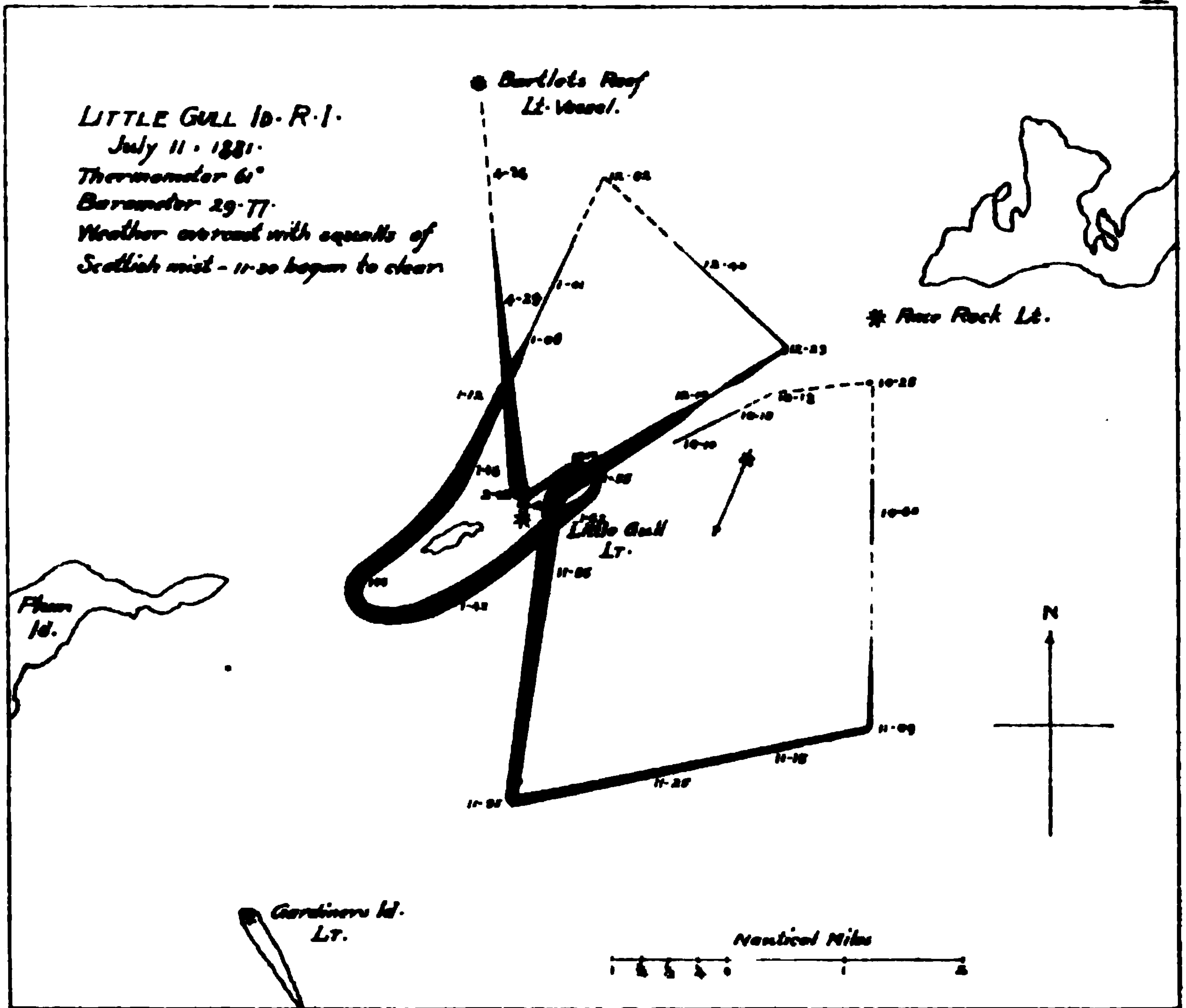
tions—Continued.

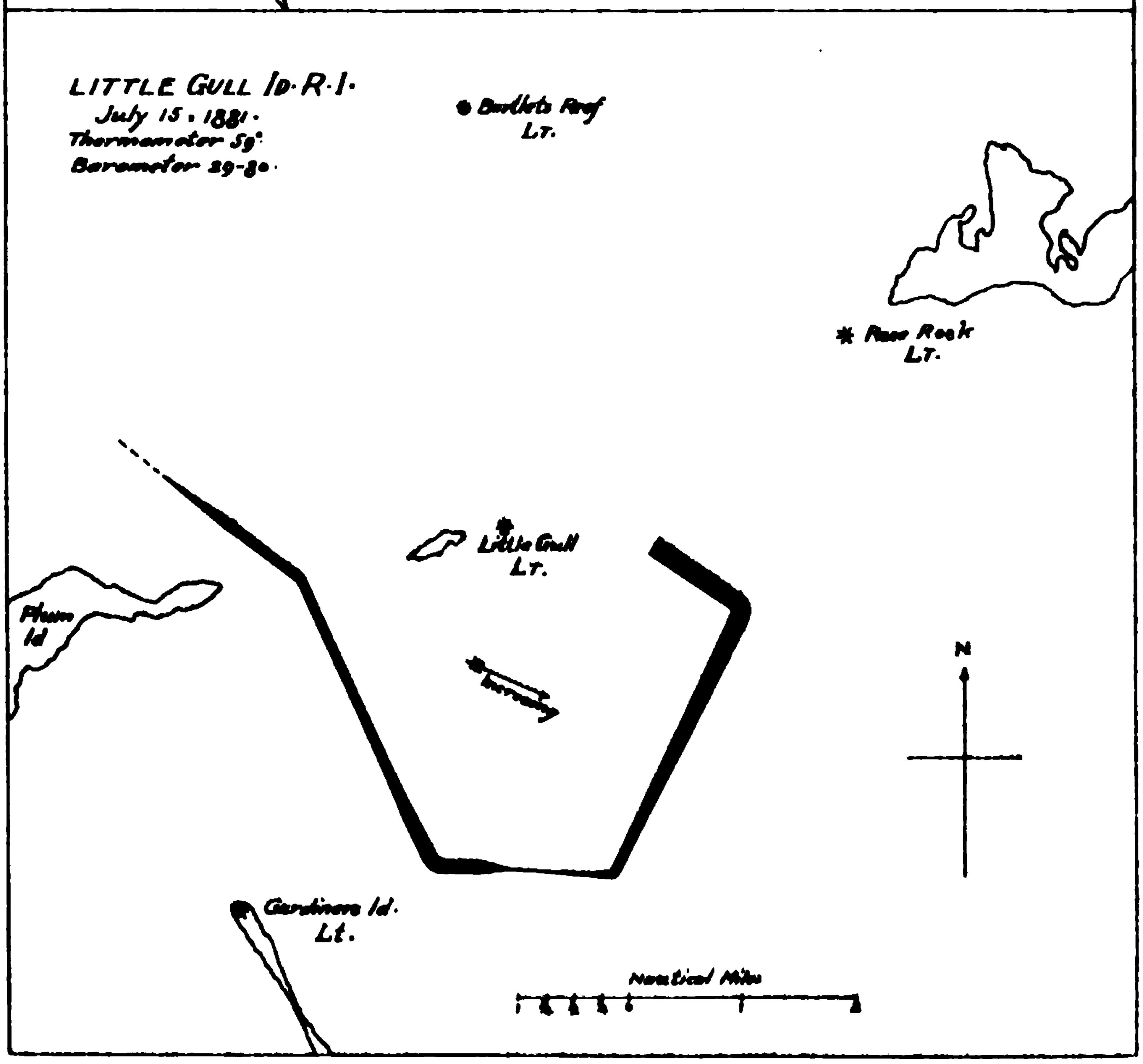
Time of day.	Audibility.	Distance.	Direction.	Wind. Velocity.	Wind. Direction.	Wind. Angle.	Temperature of air.	Barometer.	Sea.	Sky.
		Miles.		*Knots.*		*Deg*	*Deg*	*Inches.*		
4.17 p.m.	Plain ...	10¼	ESE	14	SW	10	....	30.32	Choppy ...	Threatening.
1.37 p.m.	Limit ...	1⅛	SE	8	SW	8	65	30.32	.....do	Do.
2.20 p.m.	Faint ...	6¾	SE. by S ..	....	SW	7	64	30.32	.....do	Do.
4.22 p.m.	Limit ...	1⅛	SE	....	SW	8	60	30.31	.....do	Clouded.
....	...do	0¾	E	....	SW	12	....	......	....	
....	Plain ...	3	W	8	SW	4	....	......	....	
4.20 p.m.	Limit ..	4	S	10	NE. by E .	11	40	30.35	Rough	Clear; cum. clouds in E.
4.40 p.m.	Random	4¾	SSE	12	NE. by N .	11	....	30.35	.....do	Do.
8.10 a.m.	Faint ...	4¼	SE	5	W	12	....	30.40	Smooth ...	Clear.
9.26 a.m.	Limit ...	1⅛	SW	....	W	4	....	30.40	.....do	Do.
10.23 a.m.	...do	2	W	8	WNW	2	....	30.40	.....do	Do.
11.27 a.m.	...do	2¼	NE	11	NW	8	52	30.40	.....do	Do.
11.45 a.m.	Random	3¼	NNE	....	NW	6	....	30.40	.....do	Do.
11.50 a.m.	...do	3⅛	N	....	NW. by N	3	....	30.40	.....do	Do.
11.59 a.m.	Limit ...	2¾	N	....	NW. by N	3	....	30.40	.....do	Do.
12.22 p.m.	...do	3	NW	12	NNW	2	....	30.40	.....do	Do.
....	Faint ...	6	WNW	5	SSW	8	....	......	....	
....	Limit ...	6	WNW	....	SSW	8	....	......	....	
....	Faint ...	6⅛	WNW	....	SSW	8	....	......	....	
....	Limit ...	6¾	WNW	....	SSW	8	....	......	....	

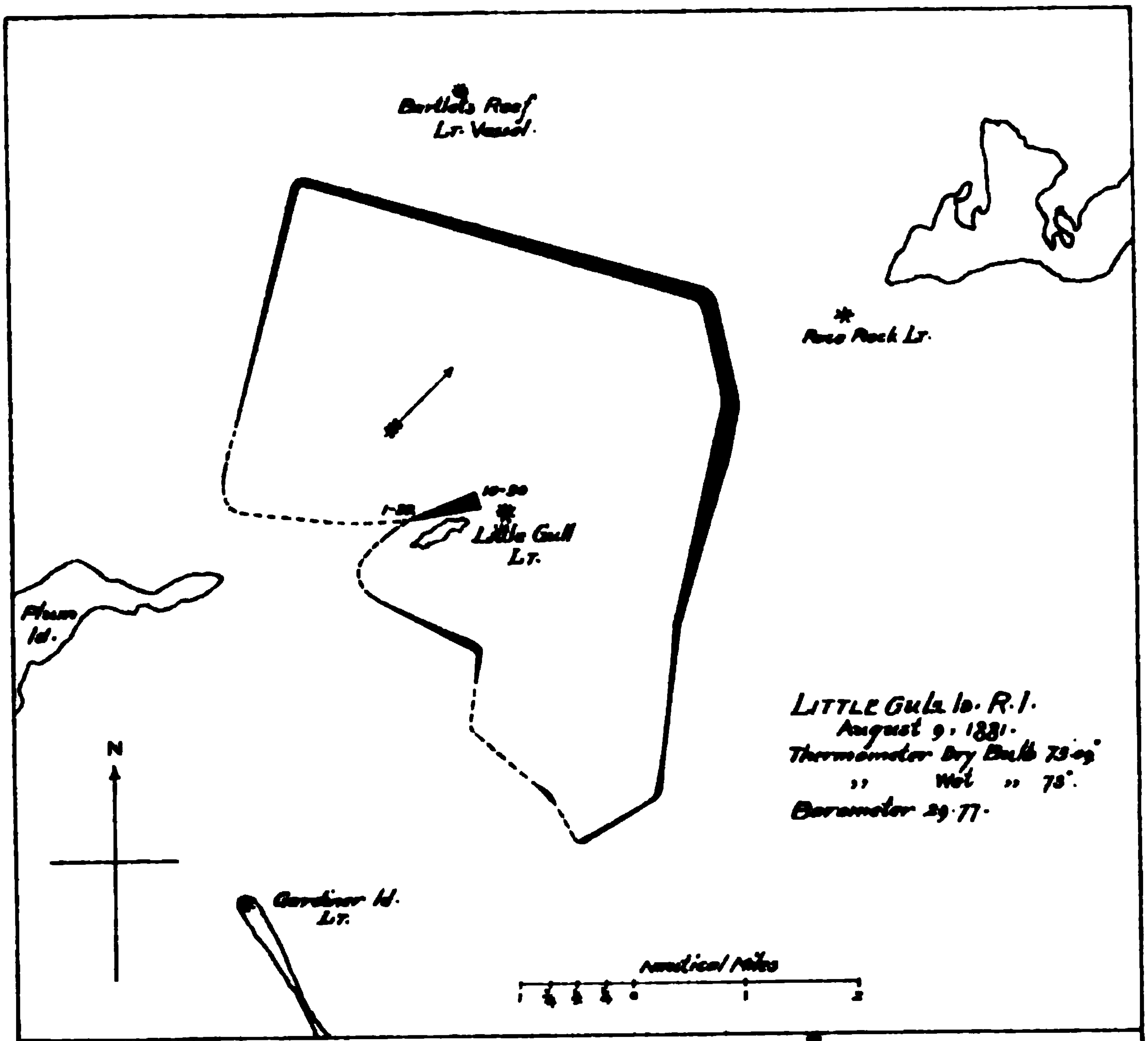
[3] At Minots Lodge.

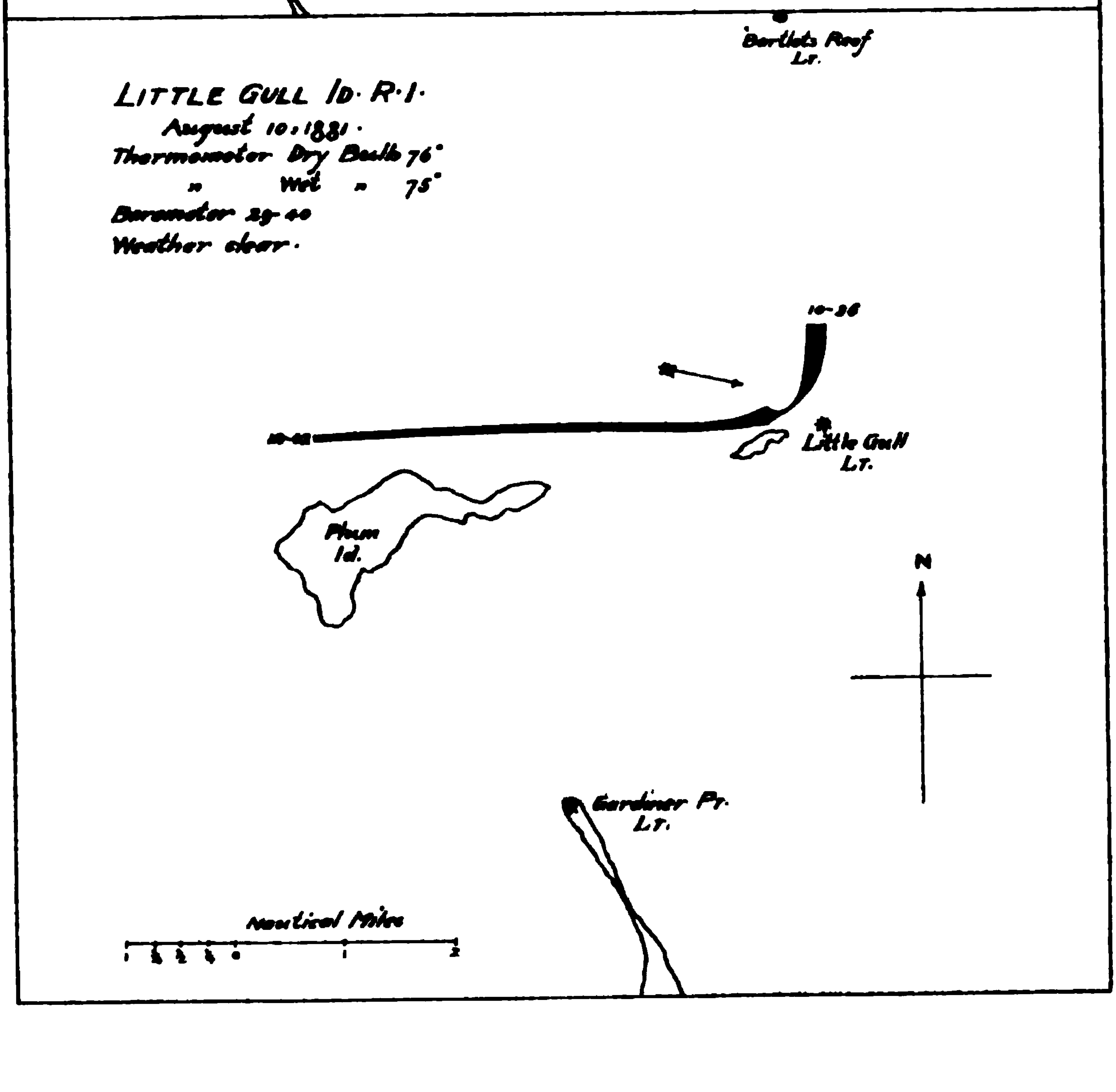
I

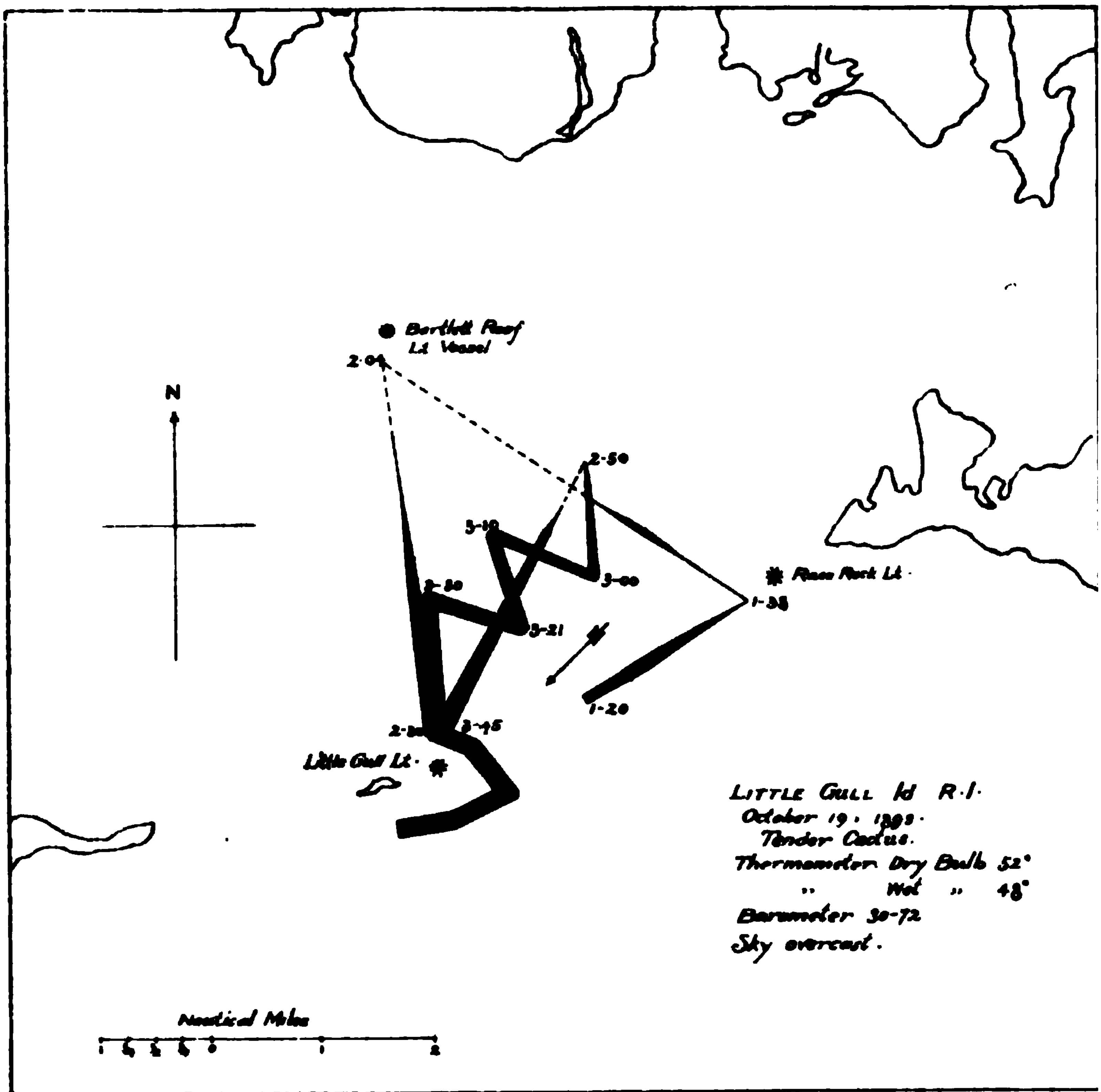

REFRACTION BY WIND.
1
F.S.
a
U
V
W
2
F.S.
a
b
U
V
W
3
F.S.
c
U
V
W
4
F.S.
U
V
W
5
F.S.
a
U
V
W
X

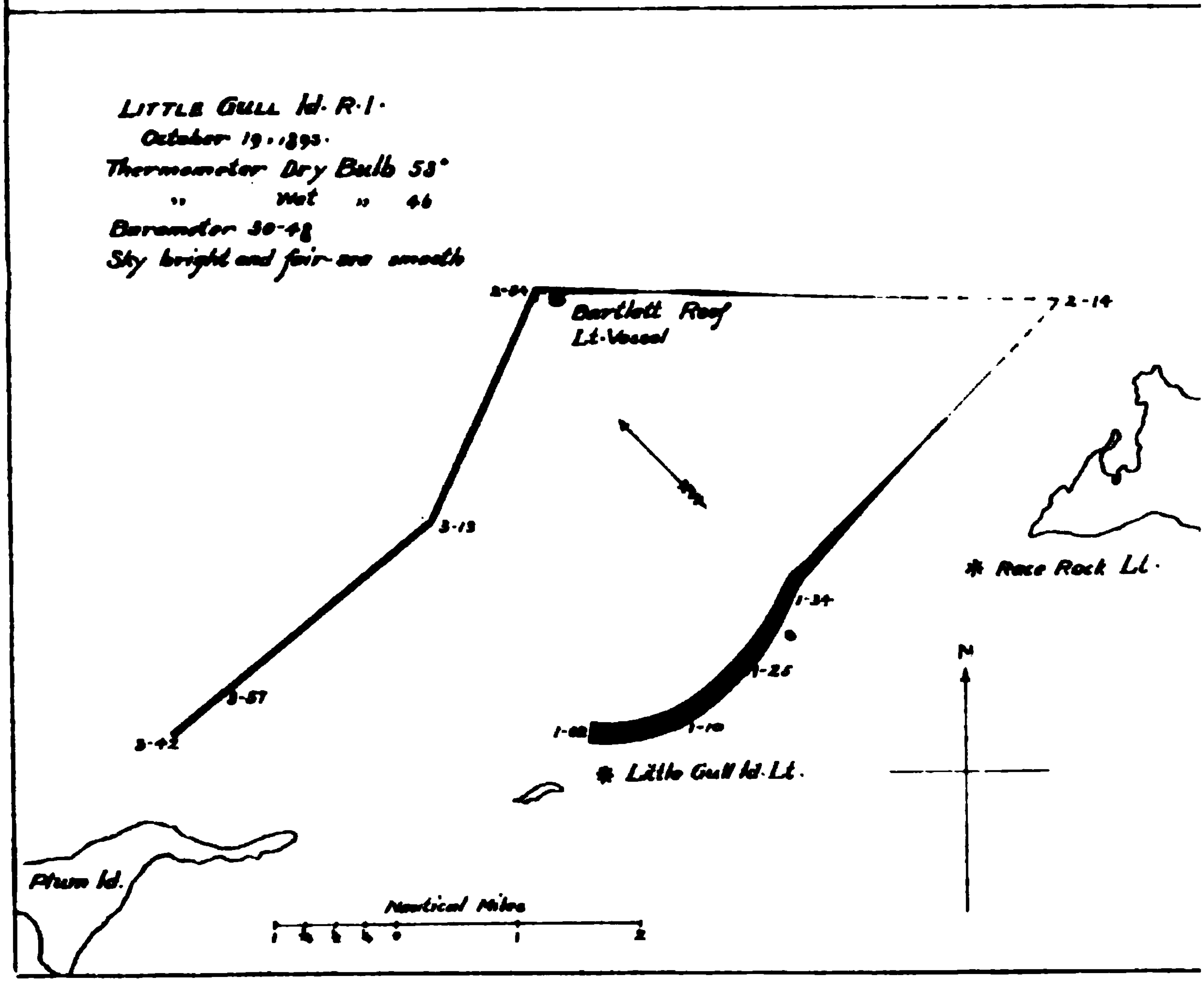

LITTLE GULL ID. R.I.
July 11. 1881.
Thermometer 61°
Barometer 29.77.
Weather overcast with squalls of Scottish mist - 11-30 began to clear
Bartlets Reef
Lt. Vessel.
Race Rock Lt.
Little Gull
Lt.
Plum
Id.
Gardiners Id.
Lt.
Nautical Miles
N

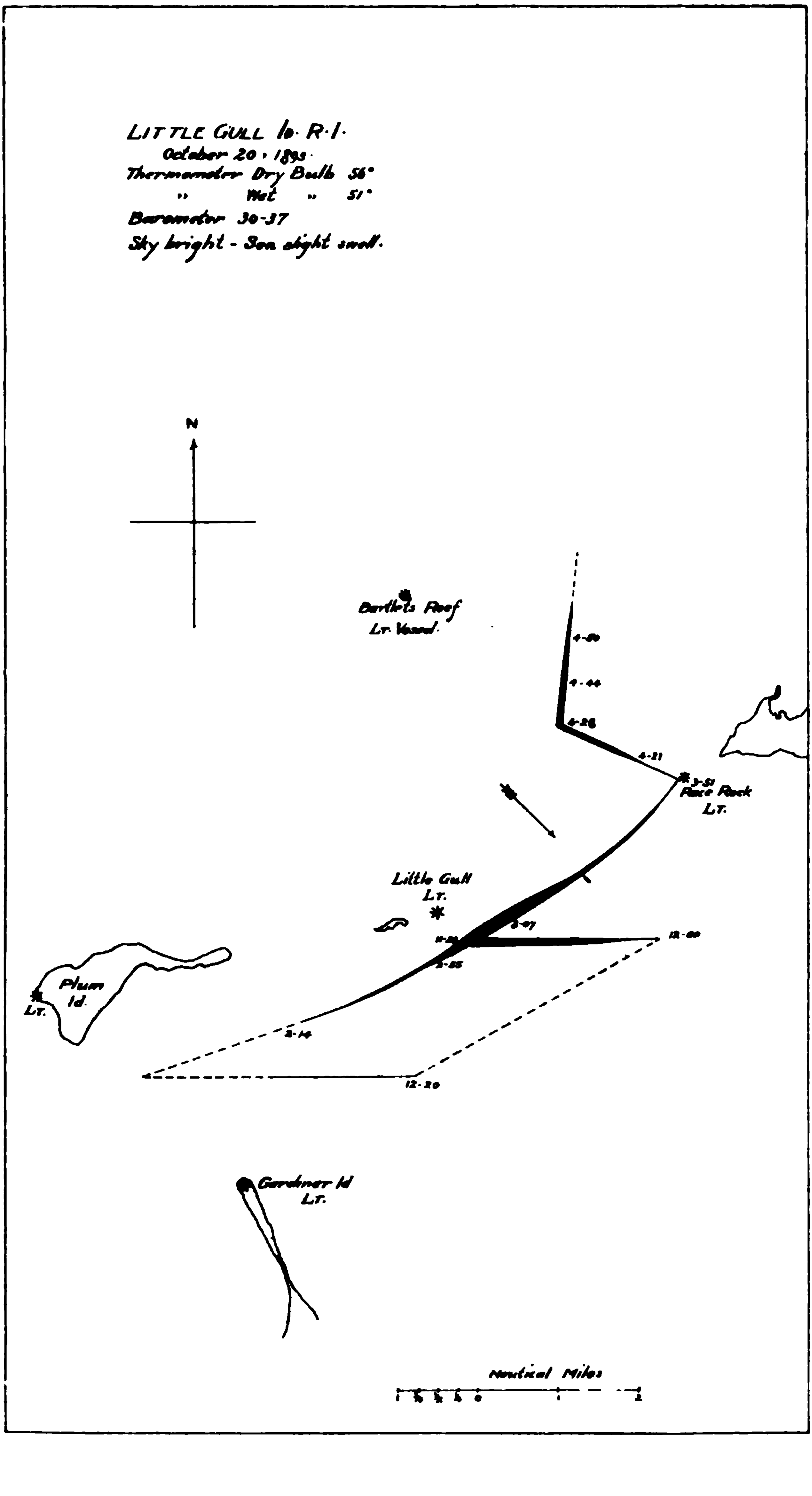

LITTLE GULL ID. R.I.
July 15. 1881.
Thermometer 59°.
Barometer 29.80.
Bartlets Reef
Lt.
Race Rock
Lt.
Little Gull
Lt.
Plum
Id
Gardiners Id.
Lt.
Nautical Miles
N


Bartlets Reef
Lt. Vessel
Race Rock Lt.
Little Gull
Lt.
Plum
Id.
LITTLE GULL ID. R.I.
August 9, 1881.
Thermometer Dry Bulb 73.09°
" Wet " 75°.
Barometer 29.77.
N
Gardiner Id.
Lt.
Nautical Miles
0
1
2

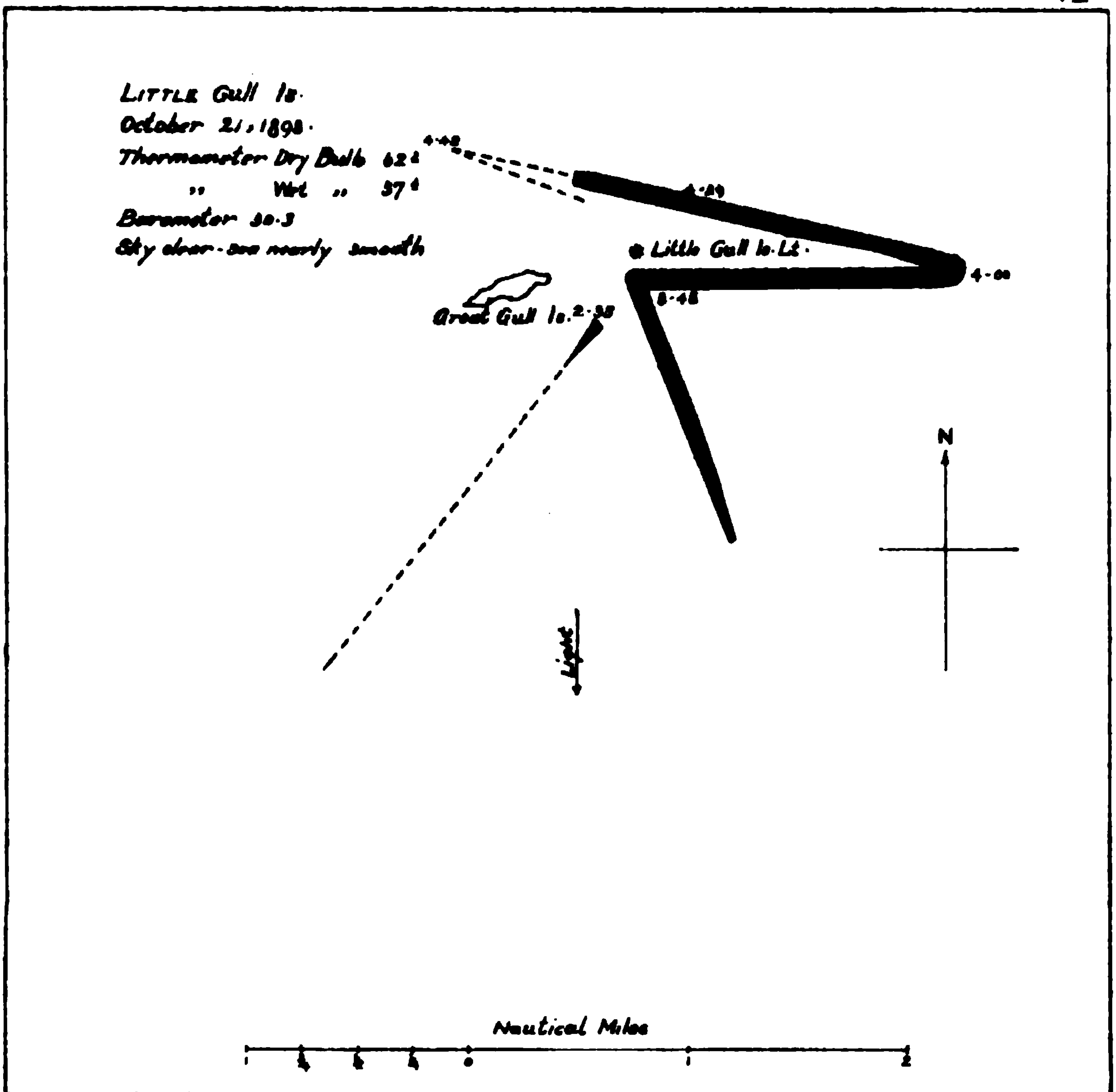

Bartlets Reef
Lt.
LITTLE GULL ID. R.I.
August 10, 1881.
Thermometer Dry Bulb 76°
" Wet " 75°
Barometer 29.40
Weather clear.
Little Gull
Lt.
Plum
Id.
N
Gardiner Pt.
Lt.
Nautical Miles
0
1
2

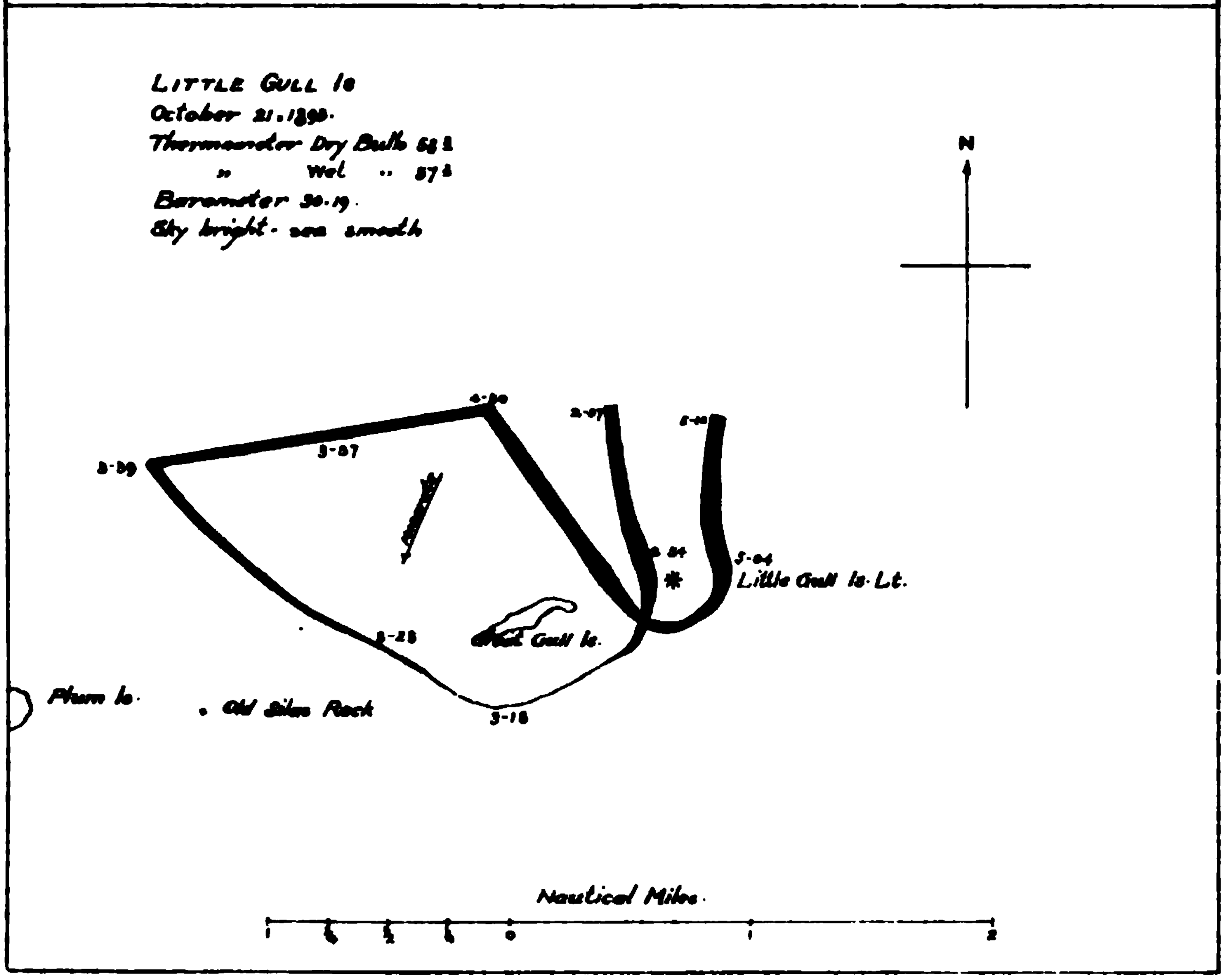

Bartlett Reef
Lt Vessel
N
Race Rock Lt.
Little Gull Lt.
Little Gull Id R.I.
October 19, 1893.
Tender Cactus.
Thermometer Dry Bulb 52°
,, Wet ,, 48°
Barometer 30-72
Sky overcast.
Nautical Miles

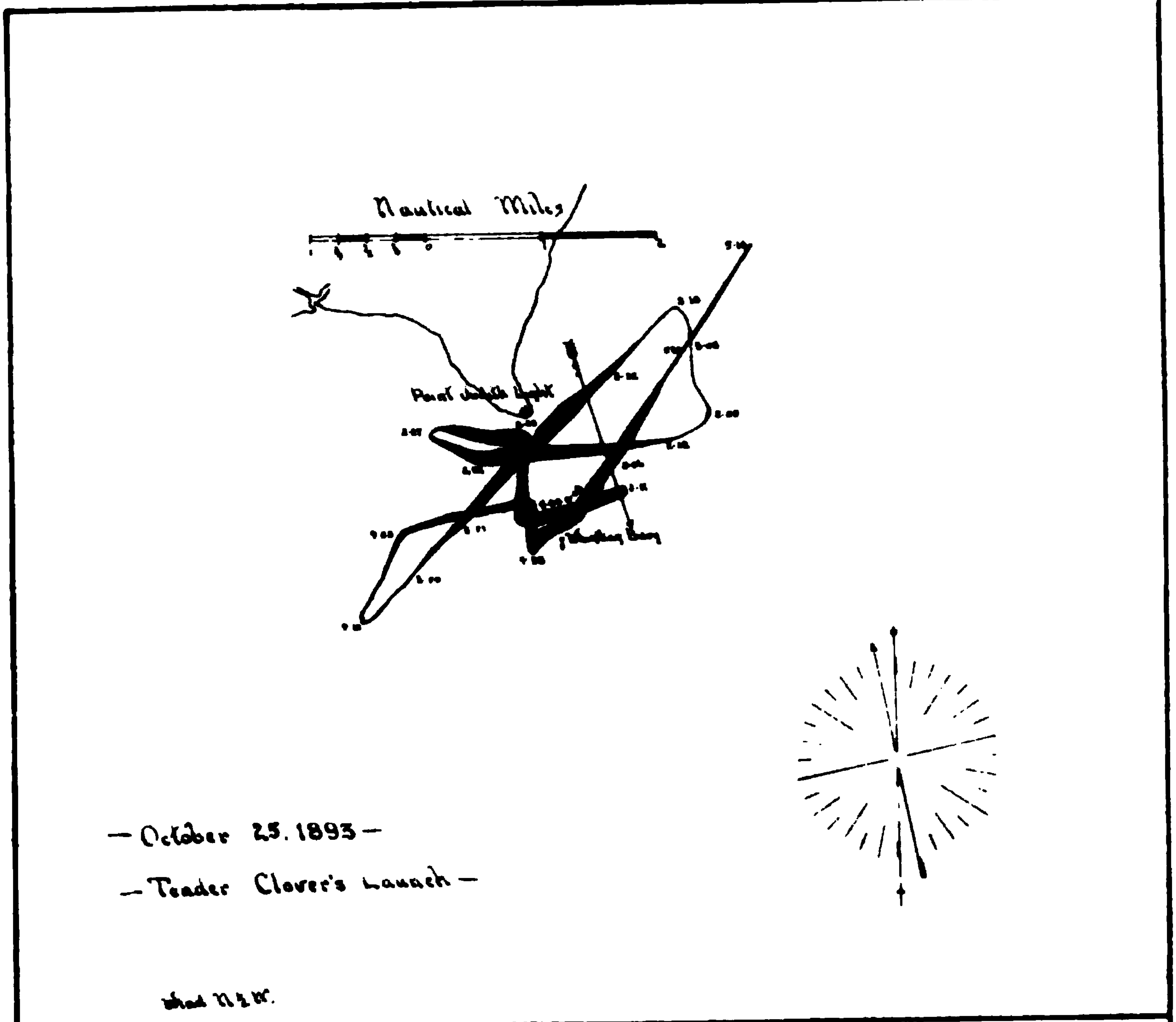

Little Gull Id. R.I.
October 19, 1893.
Thermometer Dry Bulb 53°
,, Wet ,, 46
Barometer 30-48
Sky bright and fair-sea smooth
Bartlett Reef
Lt. Vessel
Race Rock Lt.
N
Little Gull Id. Lt.
Plum Id.
Nautical Miles

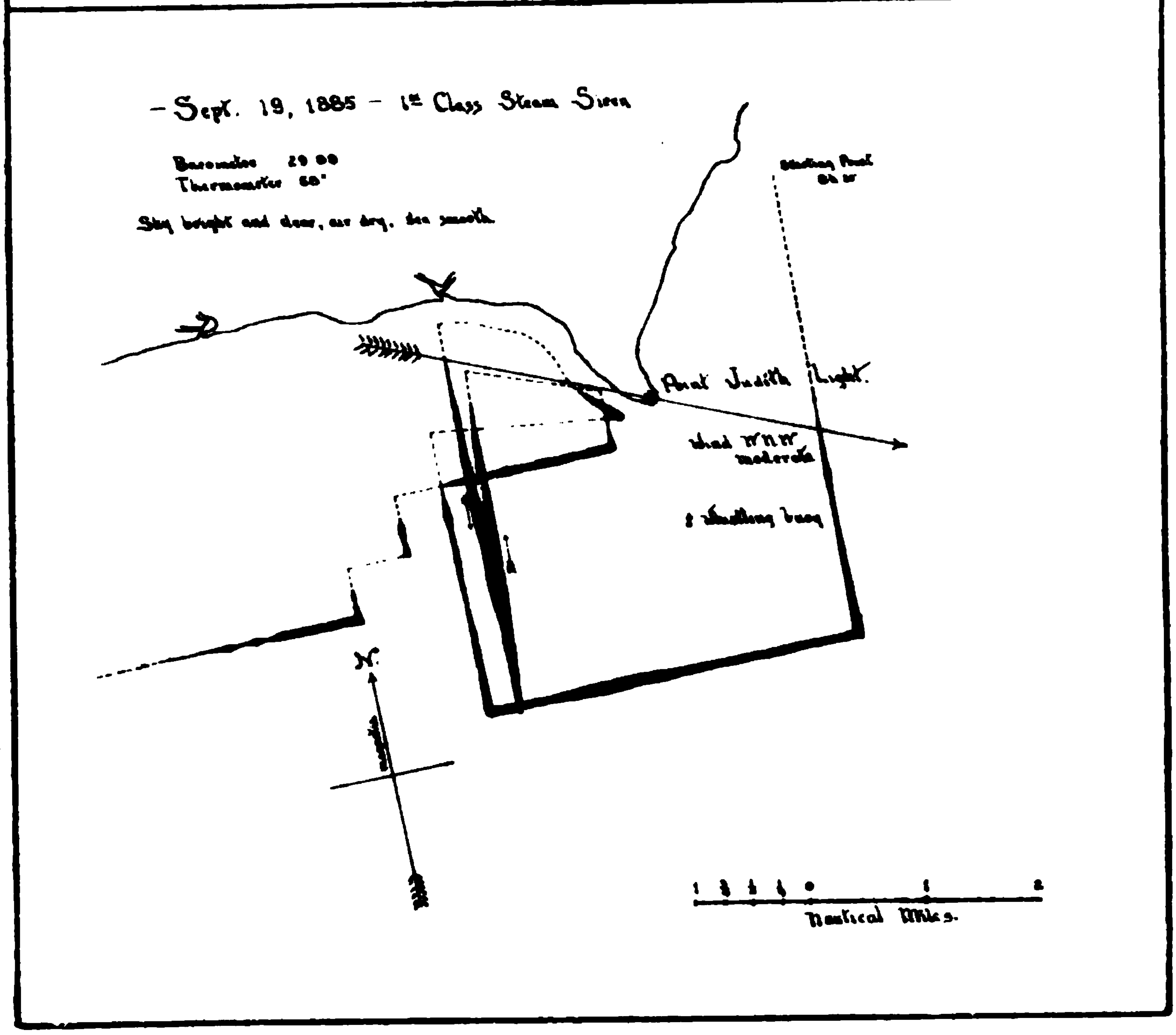


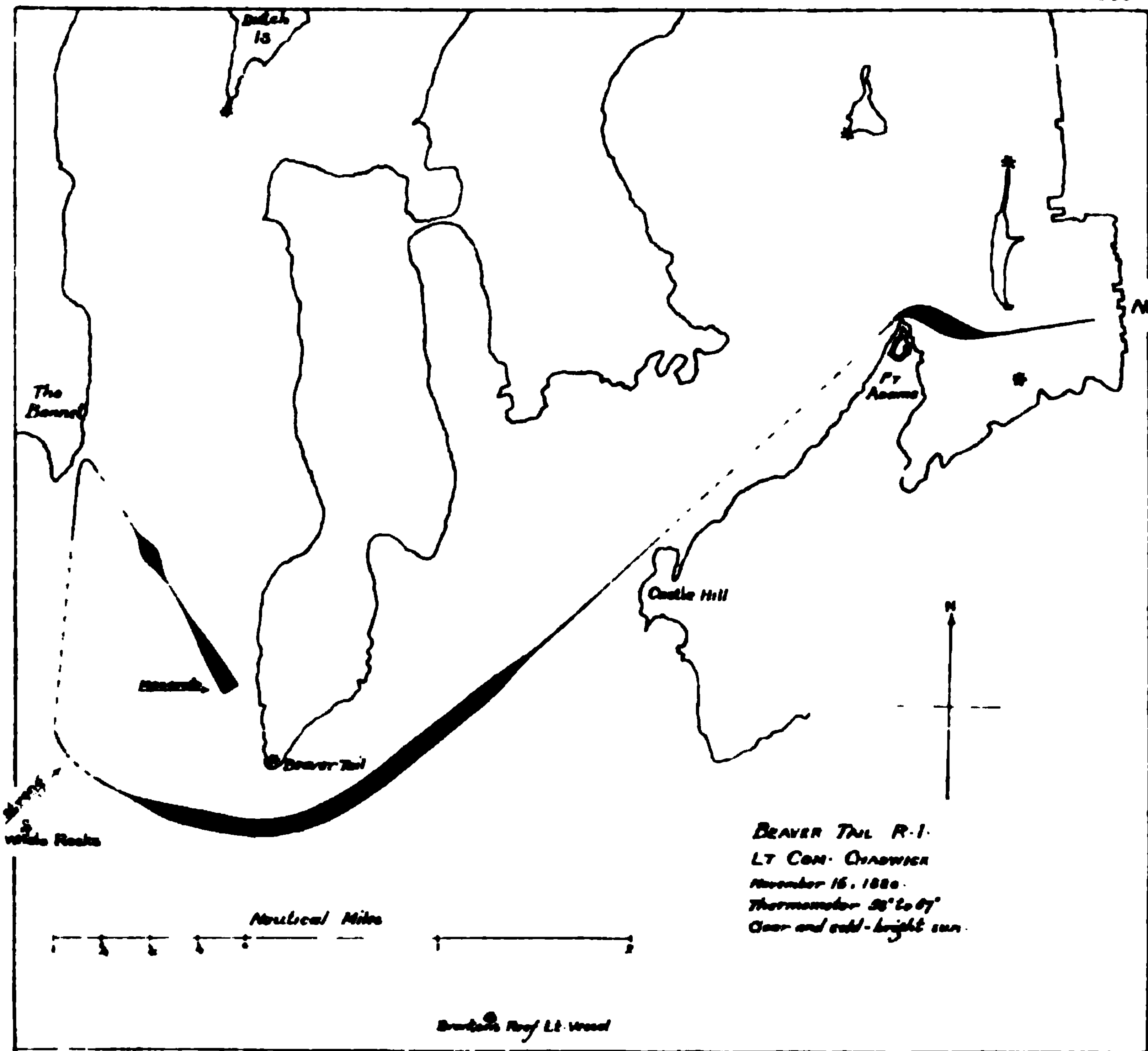
LITTLE GULL Id. R.I.
October 20, 1893.
Thermometer Dry Bulb 56°
" Wet " 51°
Barometer 30-37
Sky bright - Sea slight swell.
N
Bartletts Reef
Lt. Vessel.
4-50
4-44
4-26
4-21
3-51
Race Rock
Lt.
Little Gull
Lt.
3-07
12-00
2-55
Plum
Id.
Lt.
2-14
12-20
Gardiner Id
Lt.
Nautical Miles
0
1
2

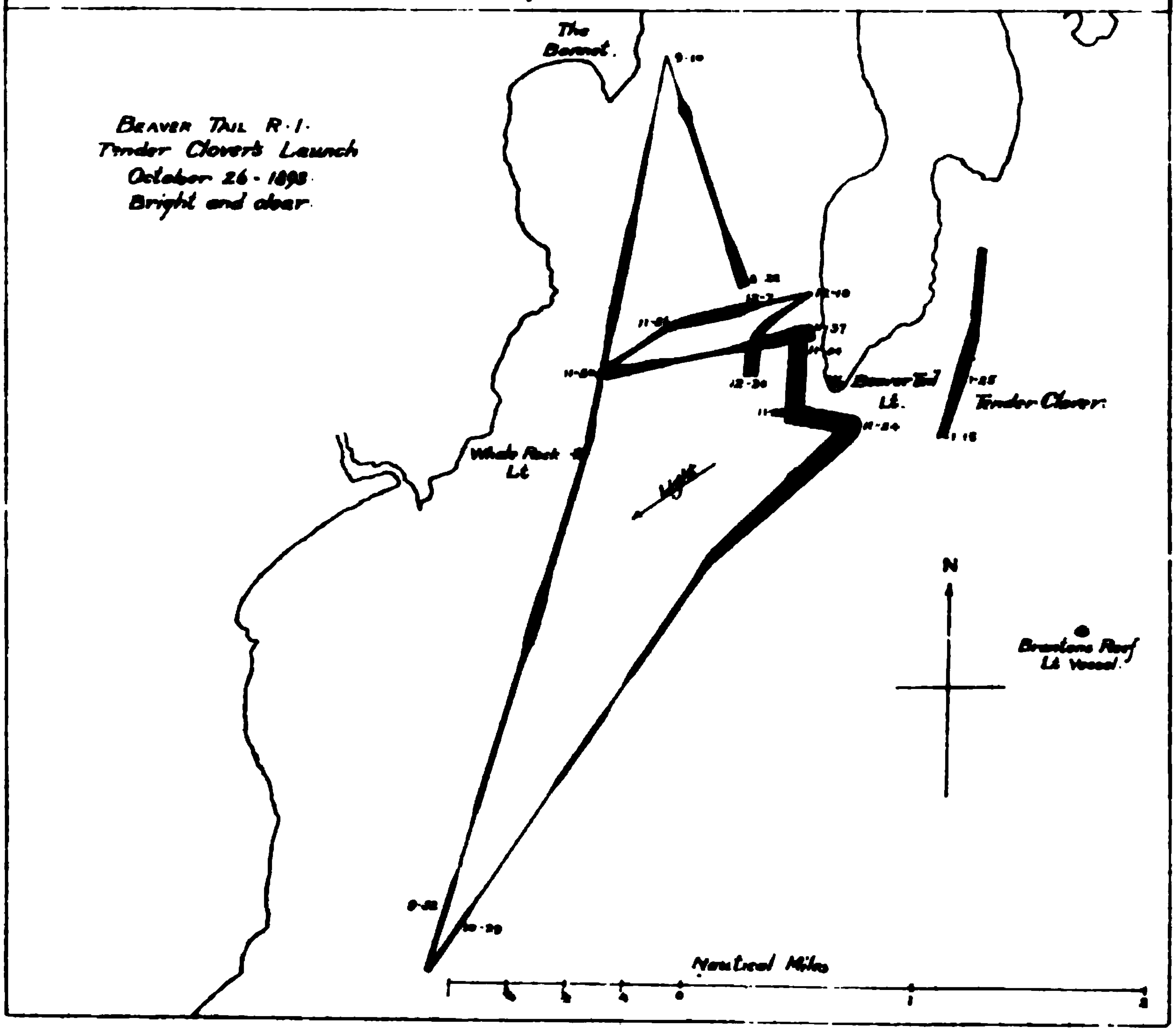

Little Gull Is.
October 21, 1898.
Thermometer Dry Bulb 62
" Wet " 57
Barometer 30.3
Sky clear - sea nearly smooth
Little Gull Is. Lt.
Great Gull Is.
N
Nautical Miles
0
1
2

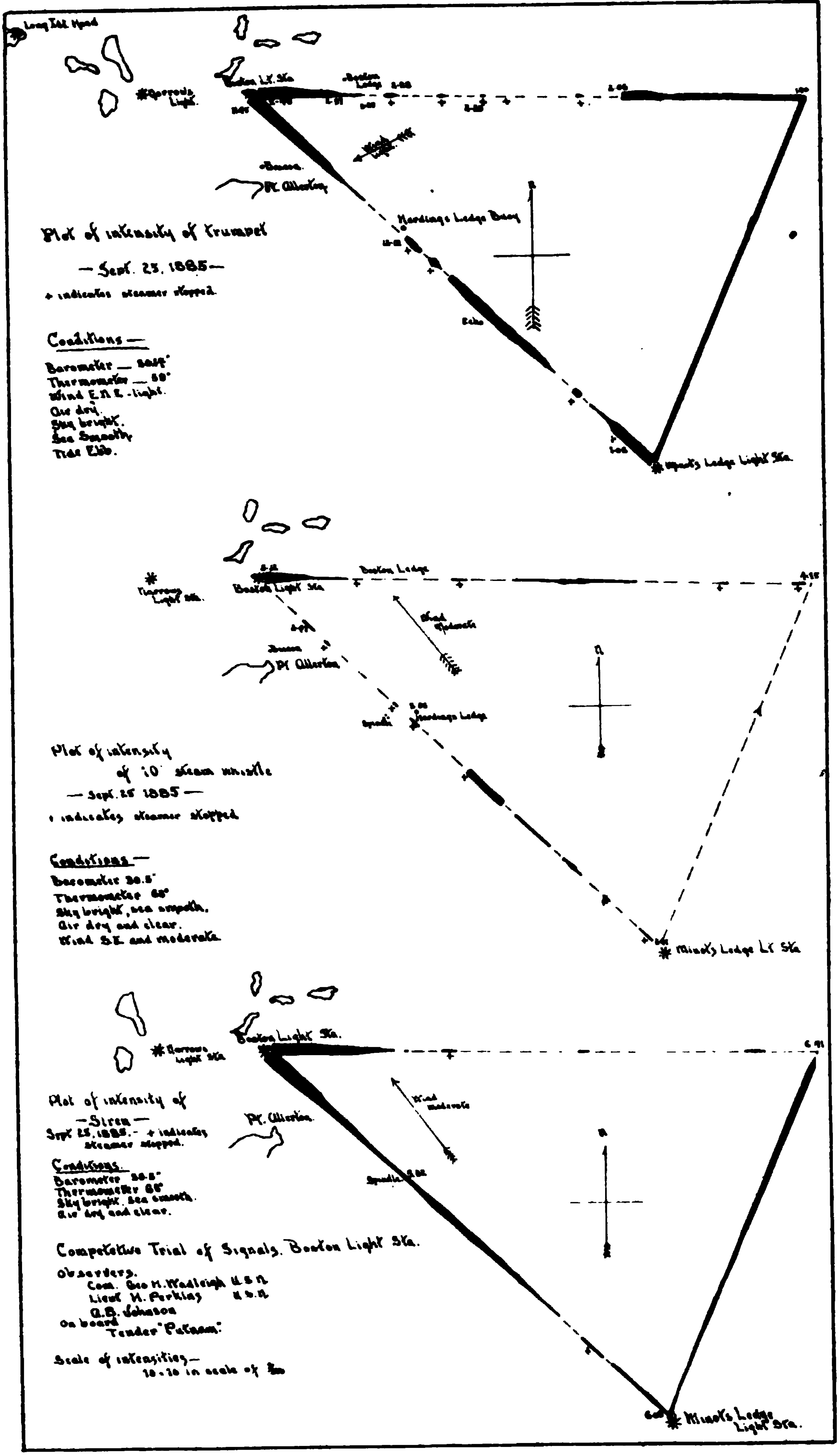

Little Gull Is
October 21. 1898.
Thermometer Dry Bulb
" Wet " 57
Barometer 30.19.
Sky bright - sea smooth
N
Little Gull Is. Lt.
Great Gull Is.
Plum Is.
Old Silas Rock
3-18
Nautical Miles.
0
1
2

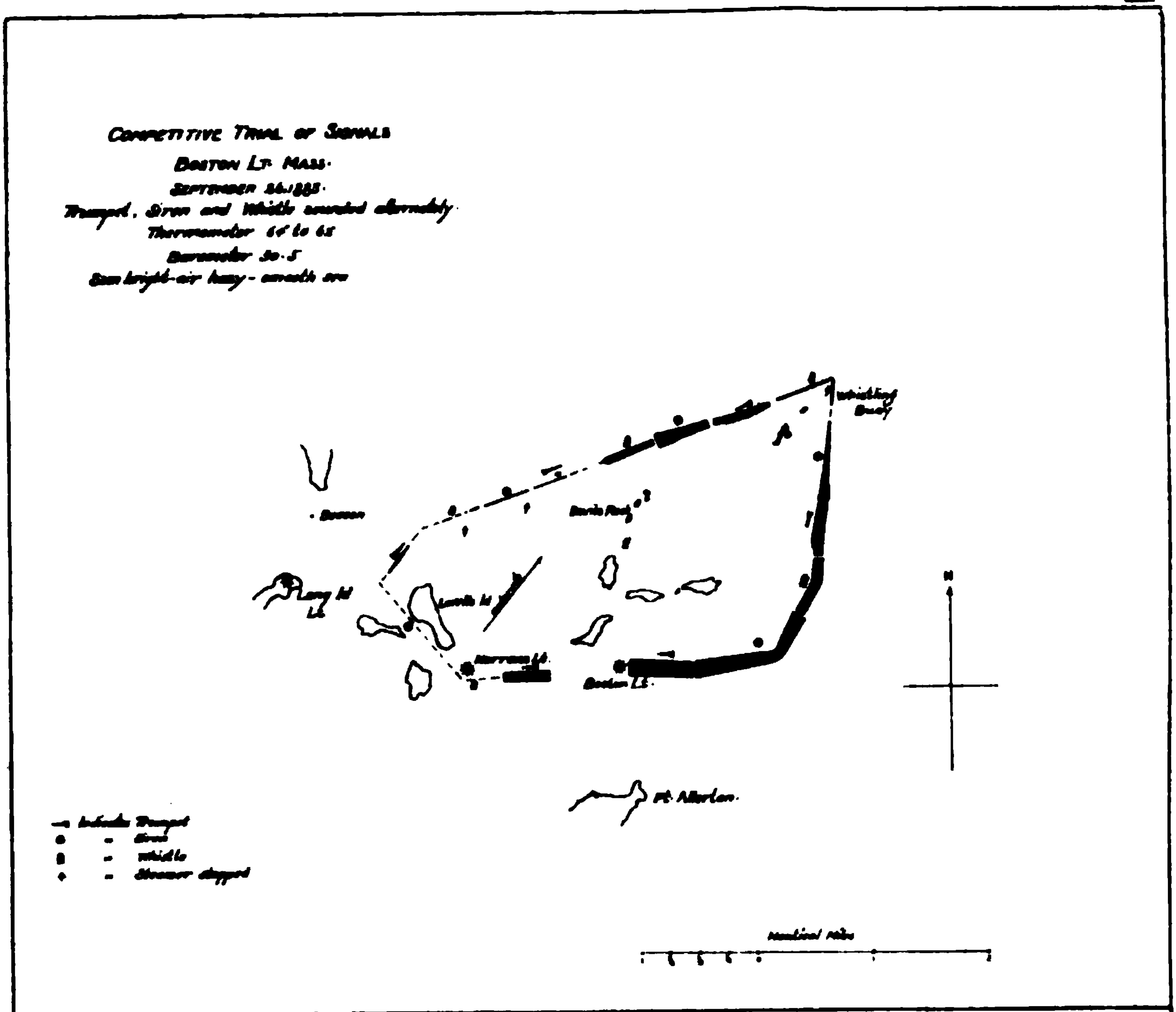

Nautical Miles
Point Judith Light
Whistling Buoy
— October 25. 1893 —
— Tender Clover's Launch —
Wind N. E. W.

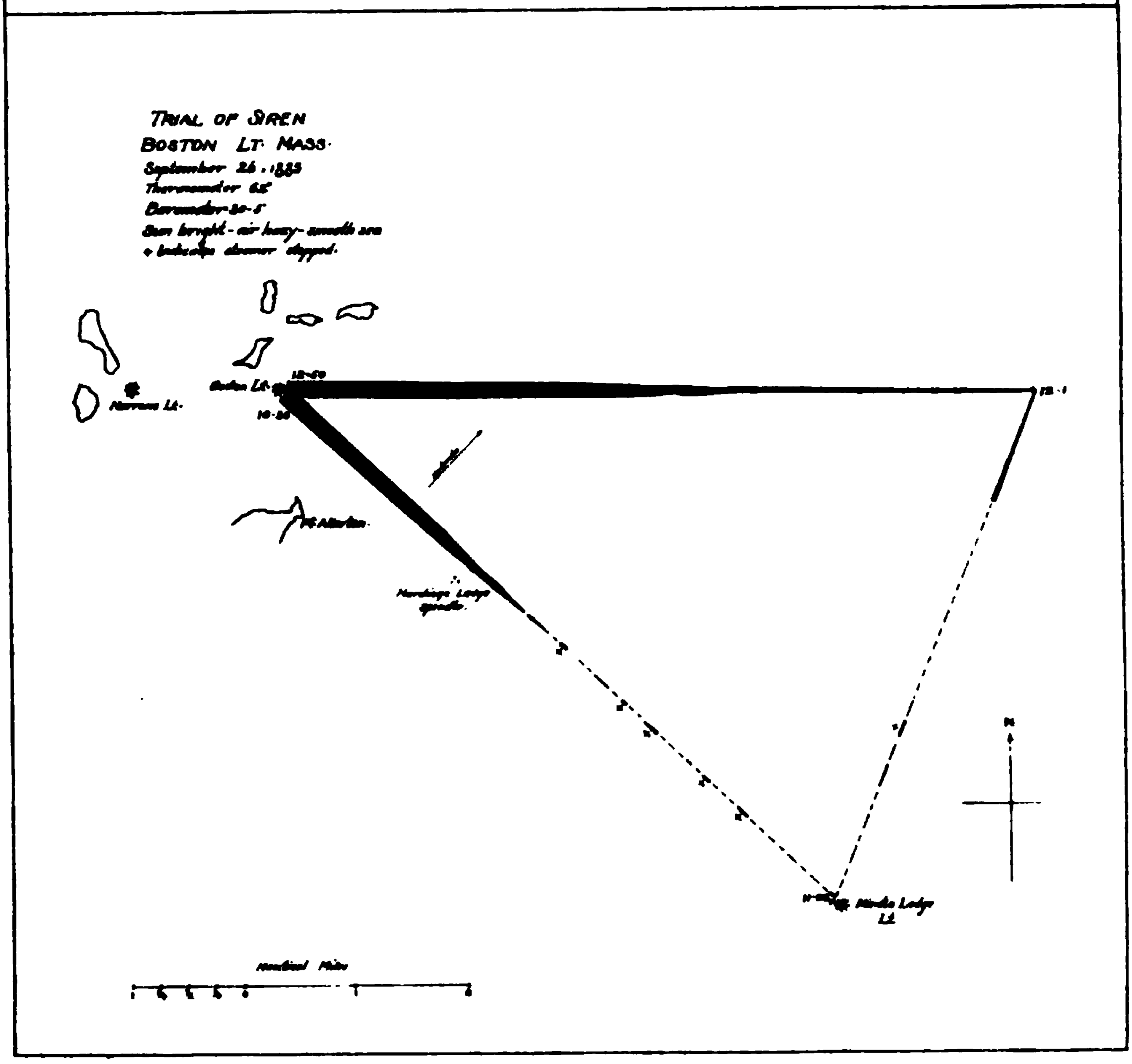

— Sept. 19, 1885 — 1st Class Steam Siren
Barometer 29 90
Thermometer 60°
Sky bright and clear, air dry. Sea smooth.
Point Judith Light.
Wind W N W moderate
Whistling Buoy
N.
Nautical Miles.

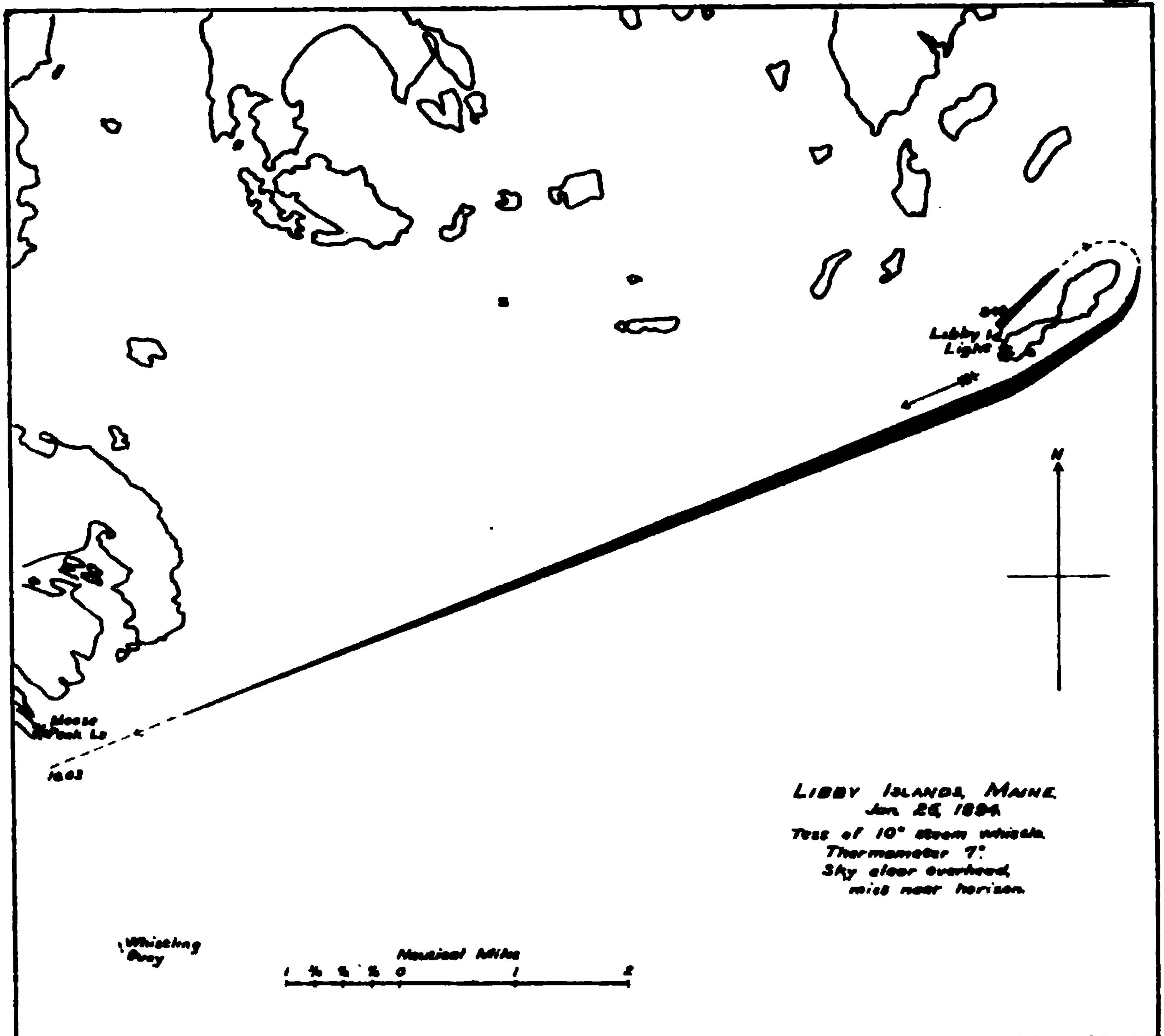

Beaver Tail R. I.
Lt Com. Chadwick
Newport
Ft Adams
Castle Hill
The Bonnet
Beaver Tail
Whale Rocks
Nautical Miles
Brenton Reef Lt. Vessel
N

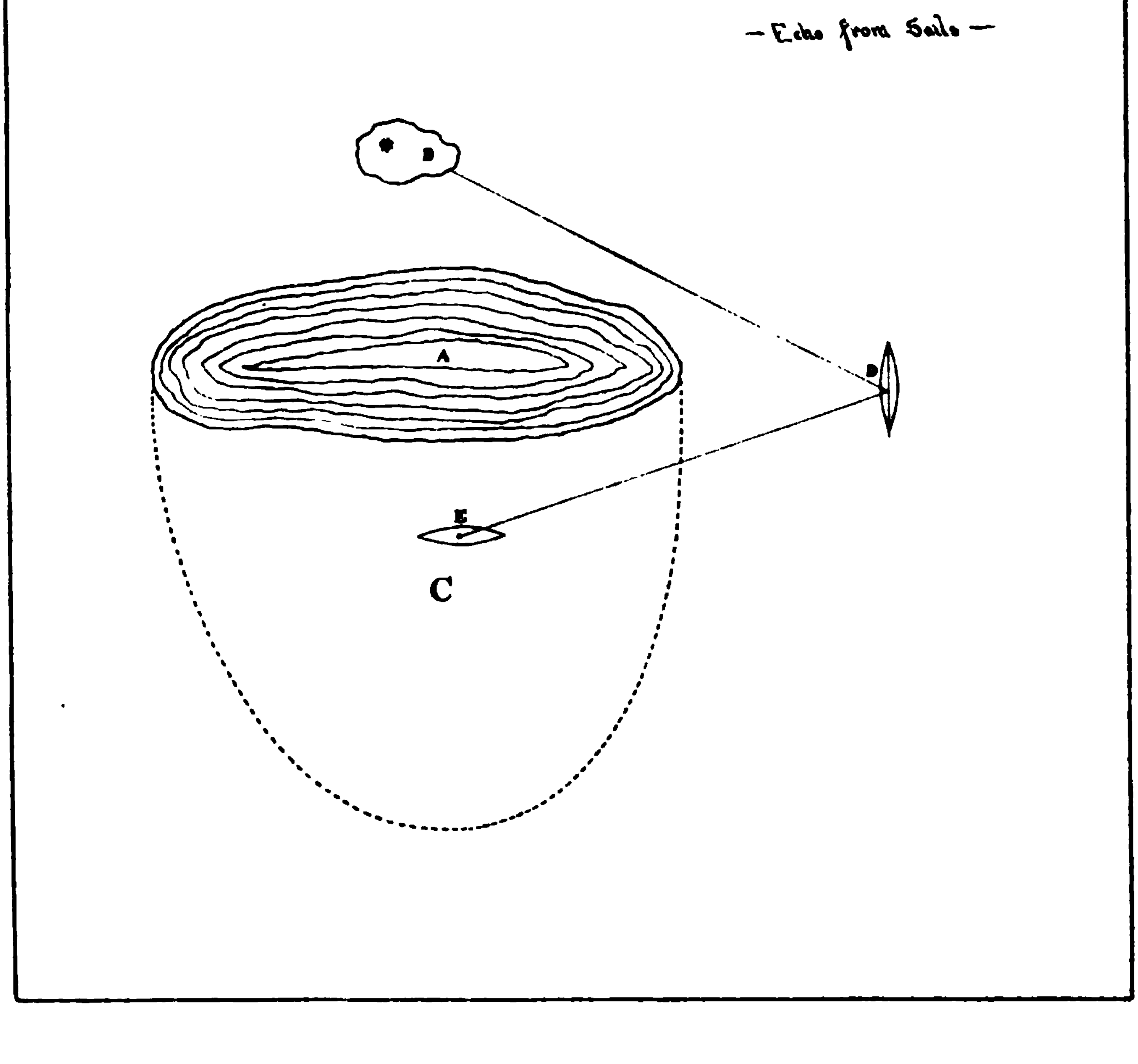

Beaver Tail R. I.
Tender Clover's Launch
October 26 - 1893
Bright and clear
The Bonnet.
9-10
Whale Rock Lt.
Beaver Tail Lt.
Tender Clover.
Brenton Reef Lt. Vessel
Nautical Miles
N


Long Isl. Head
Boston Lt. Sta.
Boston Ledge
Hardings Ledge Buoy
Pt. Allerton
Minots Ledge Light Sta.
Plot of intensity of trumpet
— Sept. 25. 1885 —
+ indicates steamer stopped.
Conditions —
Barometer — 30.5"
Thermometer — 59°
Wind E.N.E. - light.
Air dry.
Sky bright.
Sea Smooth.
Tide Ebb.
Boston Ledge
Boston Light Sta.
Pt. Allerton
Hardings Ledge
Minots Ledge Lt Sta.
Plot of intensity
of 10" steam whistle
— Sept. 25 1885 —
+ indicates steamer stopped
Conditions —
Barometer 30.5"
Thermometer 65°
Sky bright, sea smooth.
Air dry and clear.
Wind S.E. and moderate
Boston Light Sta.
Pt. Allerton
Wind moderate
Minots Ledge Light Sta.
Plot of intensity of
— Siren —
Sept 25. 1885. - + indicates steamer stopped.
Conditions.
Barometer 30.5"
Thermometer 65°
Sky bright. Sea smooth.
Air dry and clear.
Competitive Trial of Signals. Boston Light Sta.
Observers.
Com. Geo H. Wadleigh U.S.N.
Lieut H. Perkins U.S.N.
A.B. Johnson
On board
Tender "Putnam."
Scale of intensities —
10 - 20 in scale of 2m

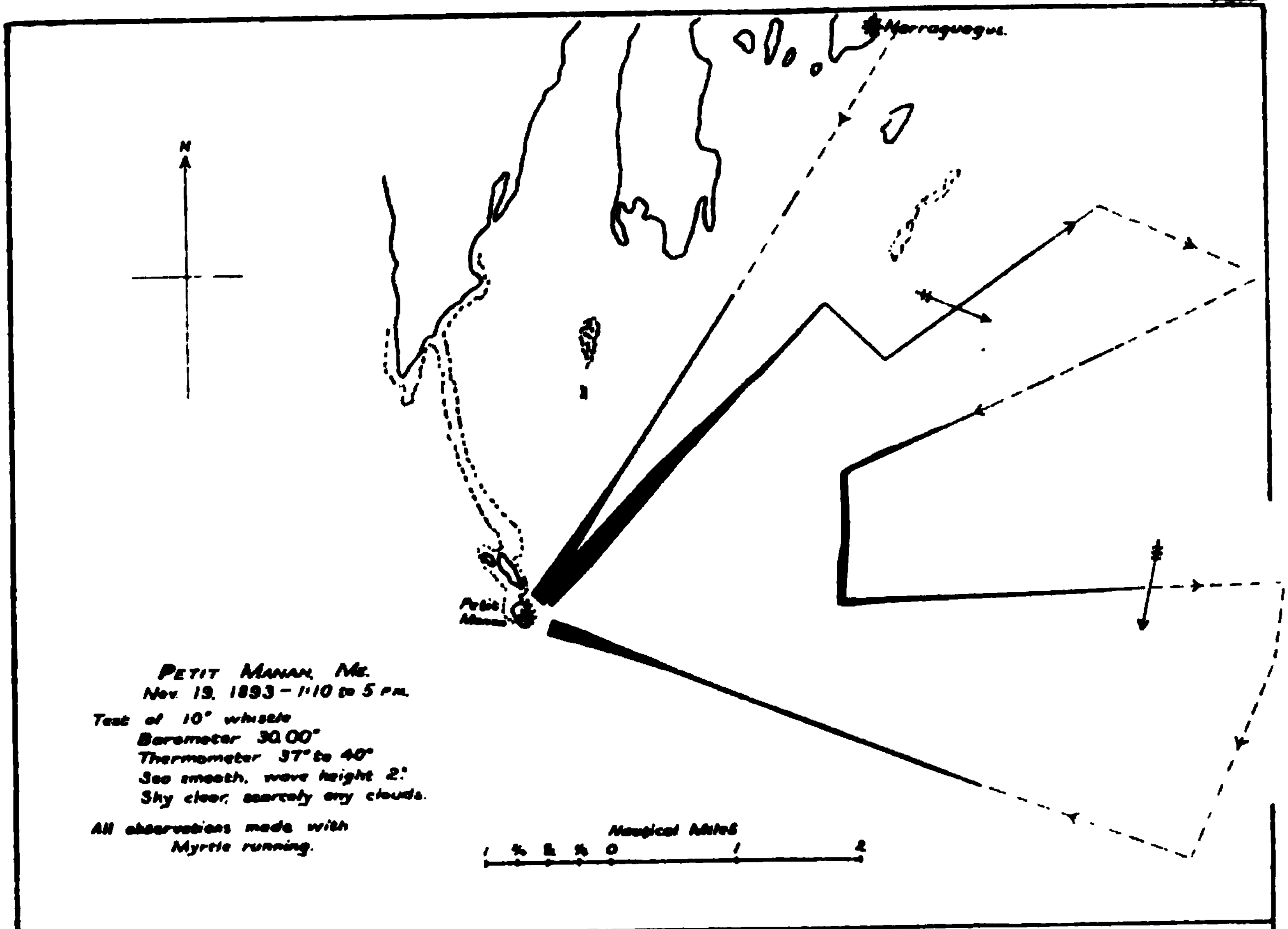

Competitive Trial of Signals
Boston Lt. Mass.
September 26. 1883.
Trumpet, Siren and Whistle sounded alternately.
Thermometer 64 to 65
Barometer 30.5
Sun bright - air hazy - smooth sea
Boston
Long Id Lt.
Lovells Id
Narrows Lt.
Boston Lt.
Whistling Buoy
Pt. Allerton
Indicates Trumpet
Siren
Whistle
Steamer stopped
Nautical Miles


Trial of Siren
Boston Lt. Mass.
September 26. 1883
Thermometer 65
Barometer 30.5
Sun bright - air hazy - smooth sea
+ indicates steamer stopped.
Boston Lt.
Narrows Lt.
Pt. Allerton
Hardings Ledge Spindle
Minots Ledge Lt.
Nautical Miles

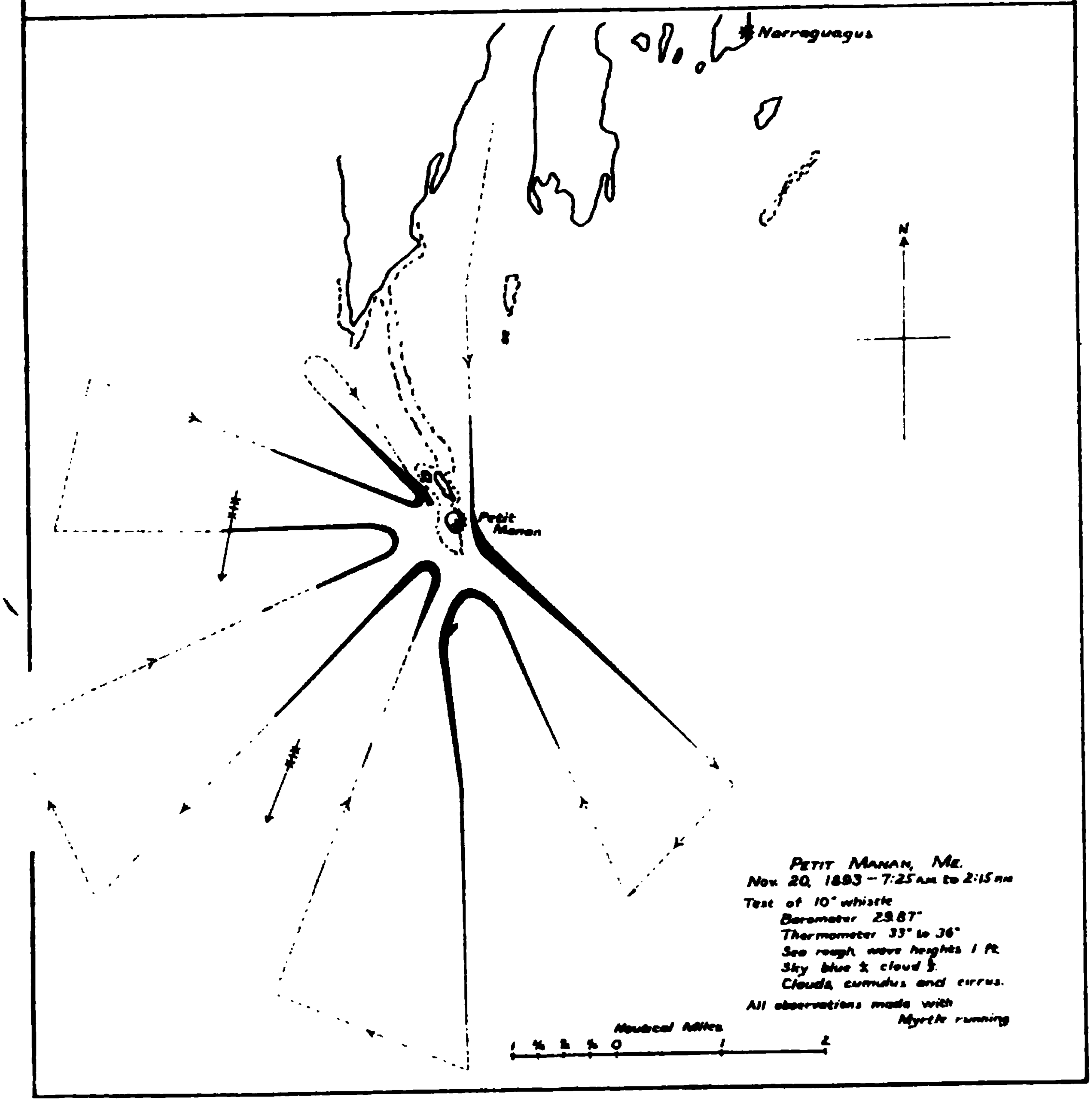

Libby Is.
Light
Moose
Peak Lt.
N
Libby Islands, Maine.
Jan. 26, 1894.
Test of 10" steam whistle.
Thermometer 7°.
Sky clear overhead,
mist near horizon.
Whistling
Buoy
Nautical Miles
1 ¾ ½ ¼ 0 1 2


— Echo from Sails —
B
A
D
E
C

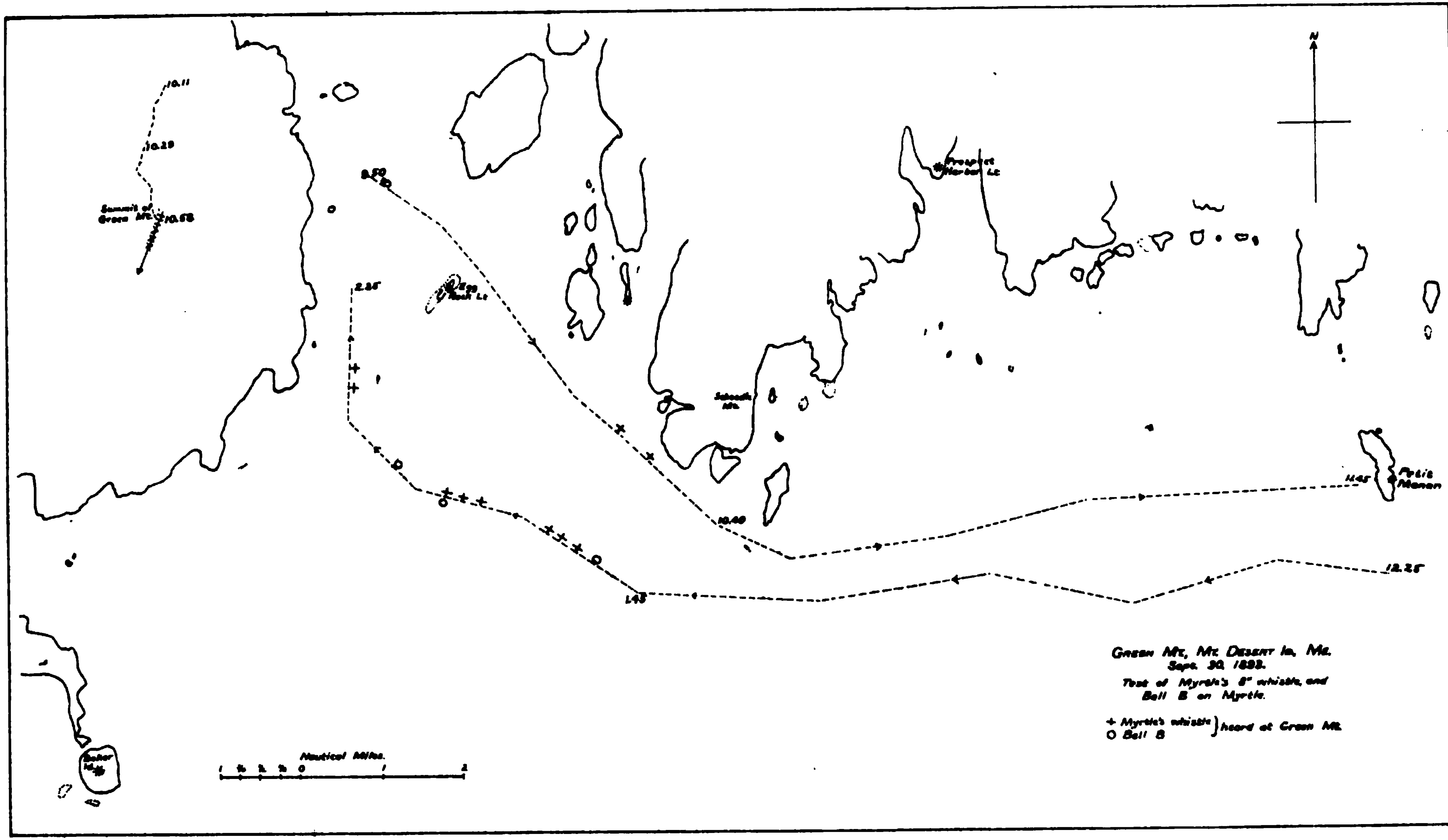
XII

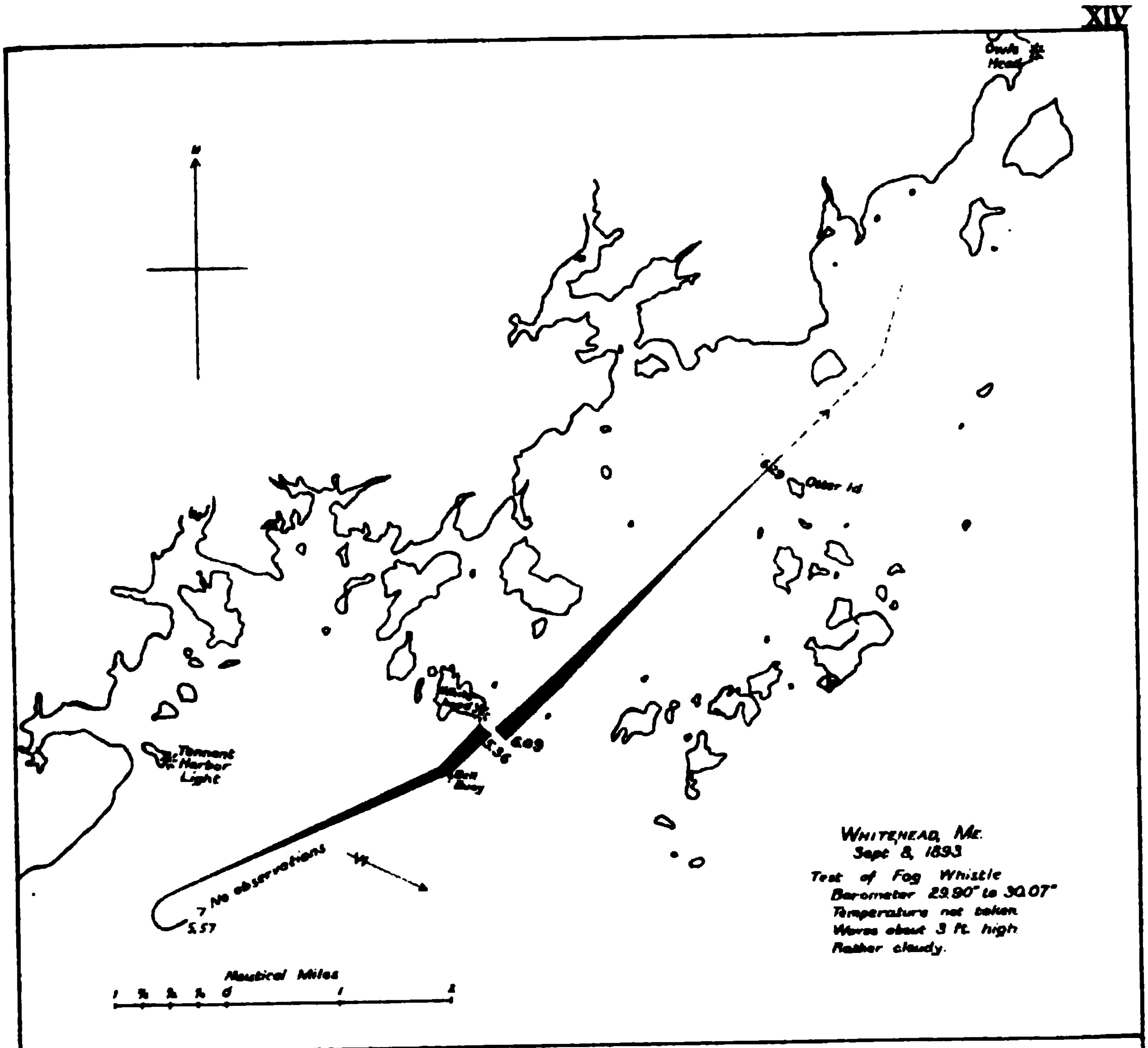


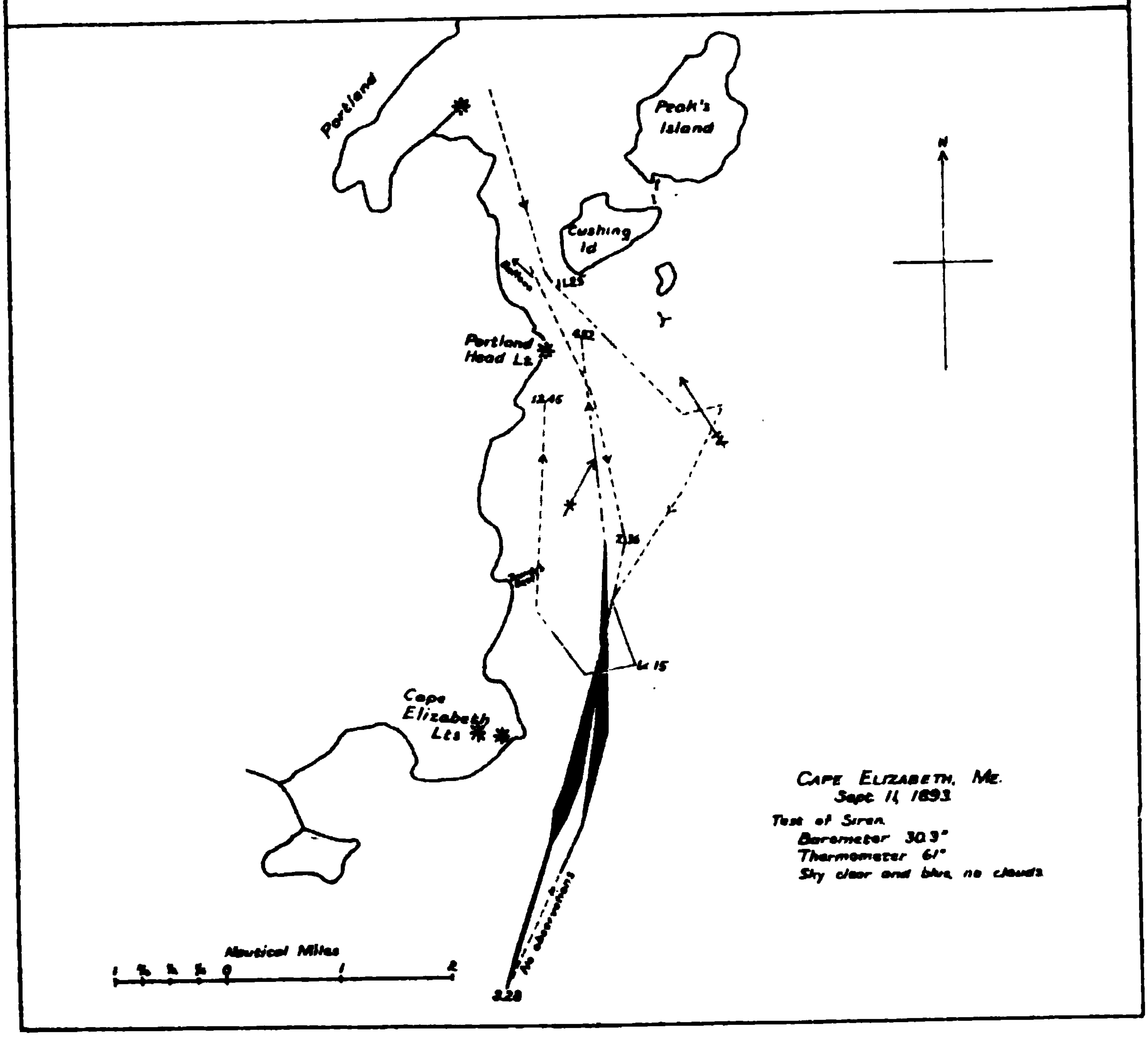
Narraguagus
N
Petit Manan
Petit Manan, Me.
Nov. 19, 1893 – 1:10 to 5 P.M.
Test of 10" whistle
Barometer 30.00"
Thermometer 37° to 40°
Sea smooth, wave height 2'
Sky clear, scarcely any clouds.
All observations made with
Myrtle running.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

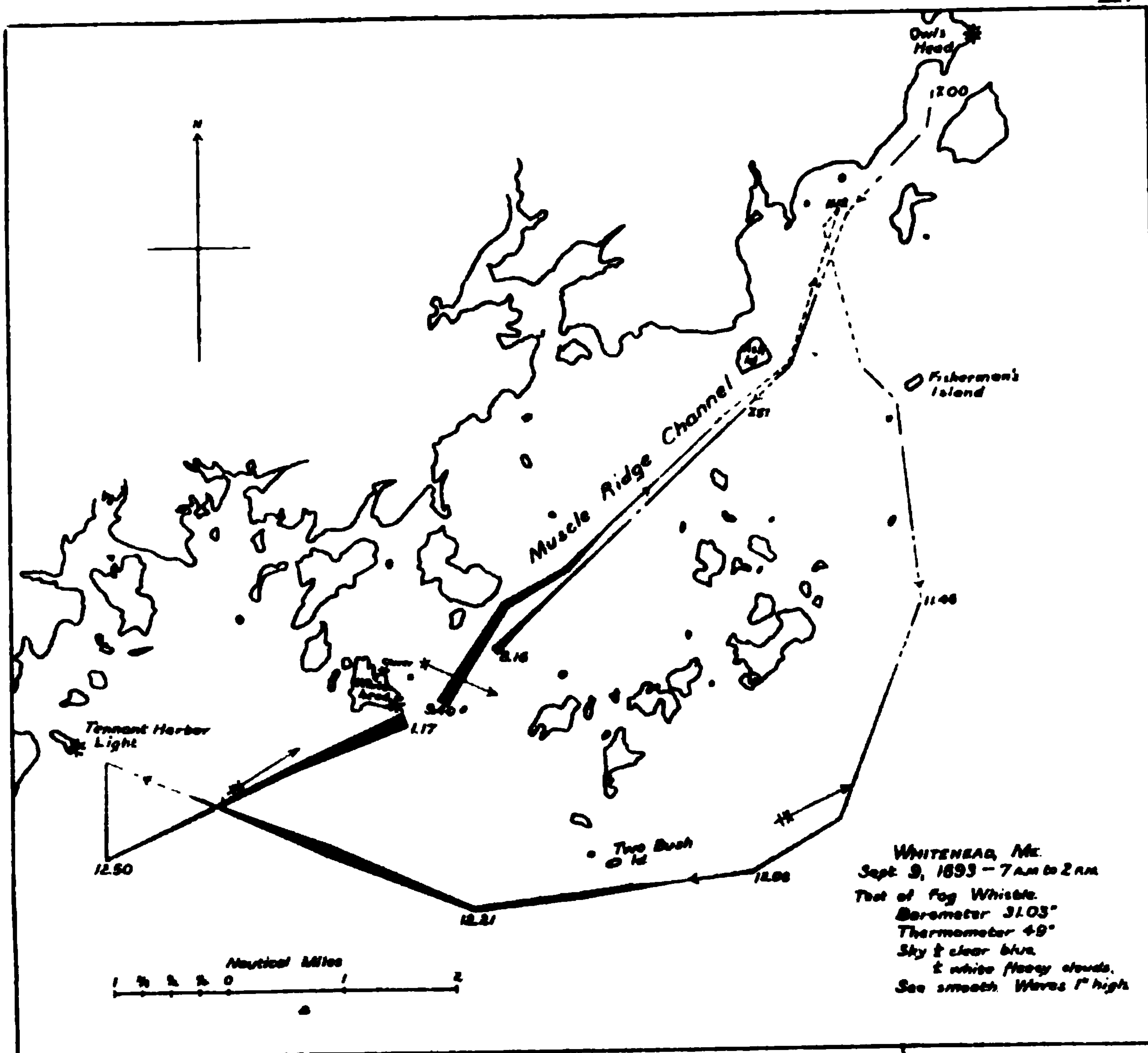


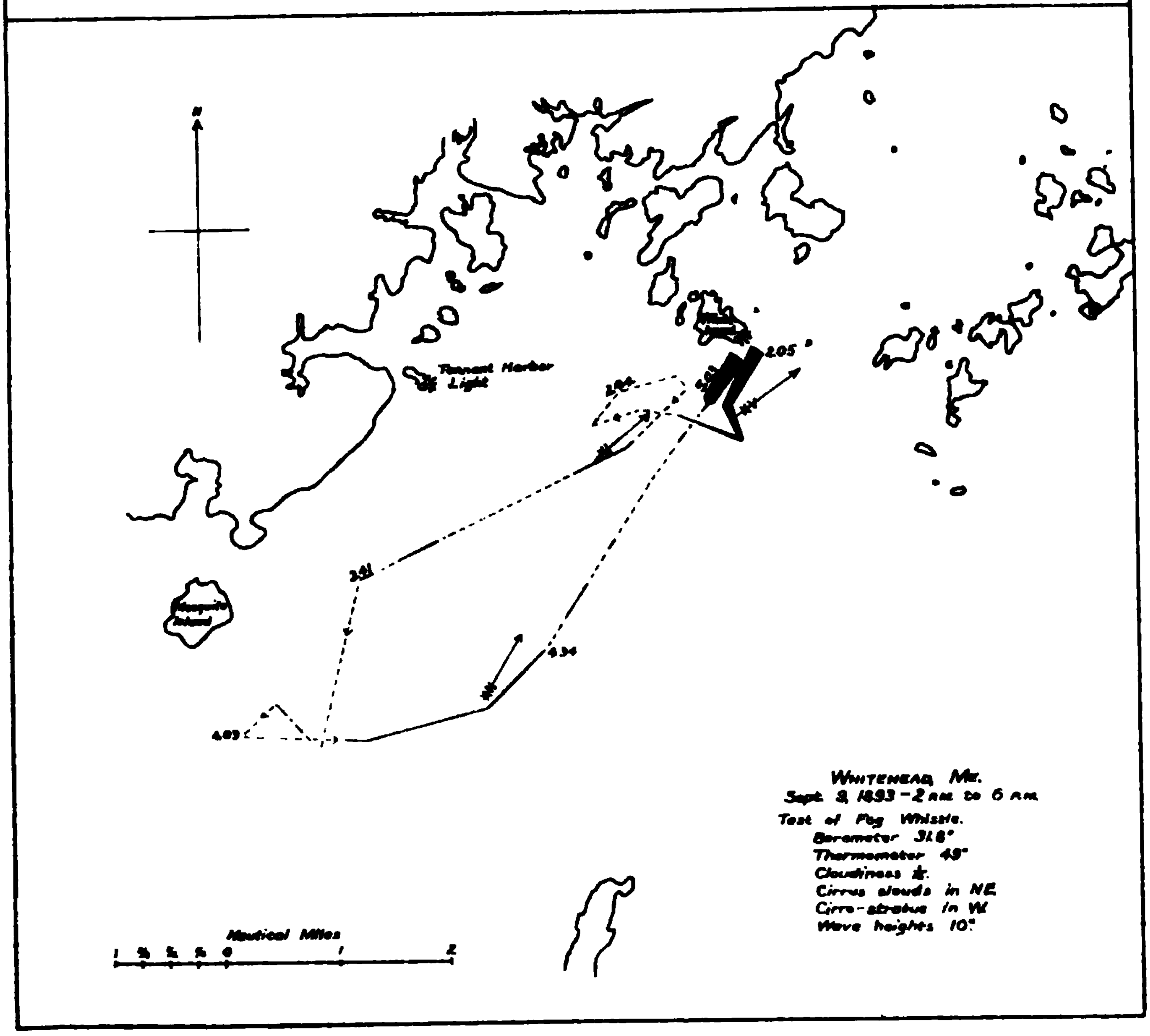
Narraguagus
N
Petit Manan
Petit Manan, Me.
Nov. 20, 1893 – 7:25 A.M. to 2:15 P.M.
Test of 10" whistle
Barometer 29.87"
Thermometer 33° to 36°
Sea rough, wave heights 1 ft.
Sky blue ½, cloud ½.
Clouds, cumulus and cirrus.
All observations made with
Myrtle running
Nautical Miles
1 ¾ ½ ¼ 0 1 2

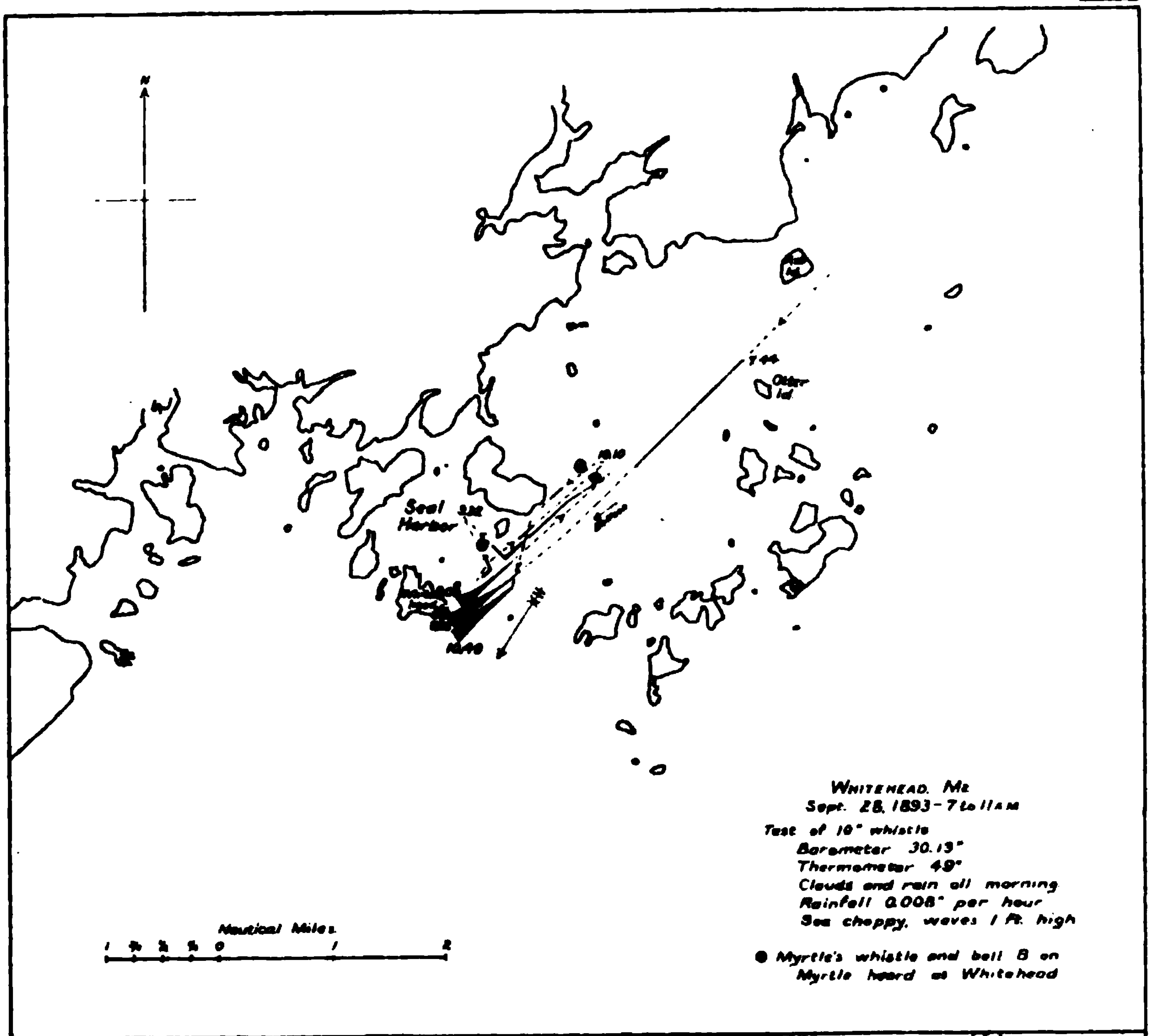

N
10.11
10.29
Summit of Green Mt.
10.58
9.50
2.35
Egg Rock Lt
Prospect Harbor Lt
Schoodic Mt.
10.40
1.43
11.45
Petit Manan
12.25
Baker Isl. Lt
Nautical Miles.
1 ¾ ½ ¼ 0 1 2
Green Mt., Mt. Desert Is., Me.
Sept. 30, 1893.
Test of Myrtle's 8" whistle, and Bell B on Myrtle.
+ Myrtle's whistle } heard at Green Mt.
O Bell B

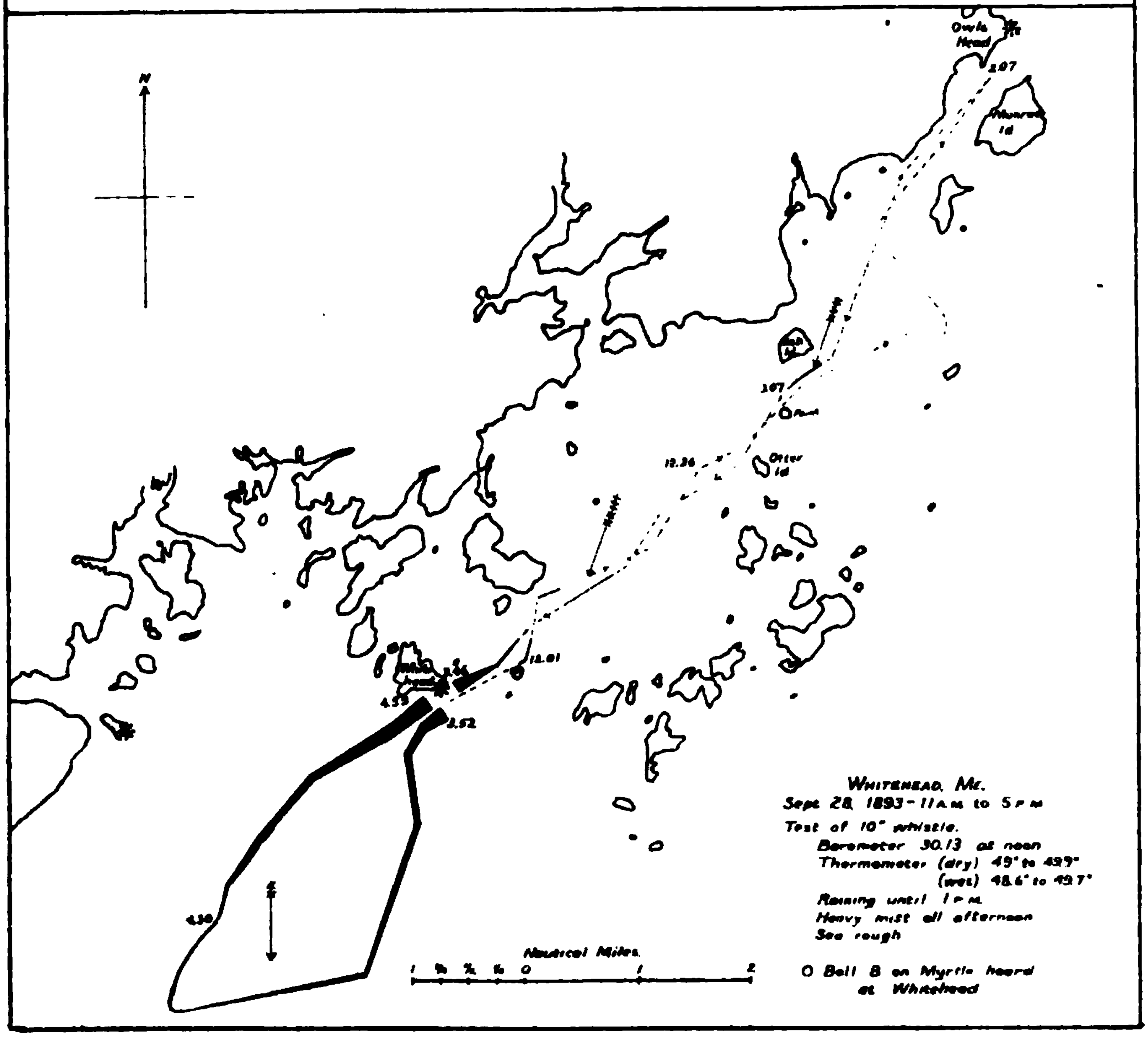

Owls Head
Otter Id
Tennant Harbor Light
Bell Buoy
5.36
6.09
No observations
5.57
N
Nautical Miles
WHITEHEAD, ME.
Sept 8, 1893
Test of Fog Whistle
Barometer 29.90" to 30.07"
Temperature not taken
Waves about 3 ft. high
Rather cloudy.

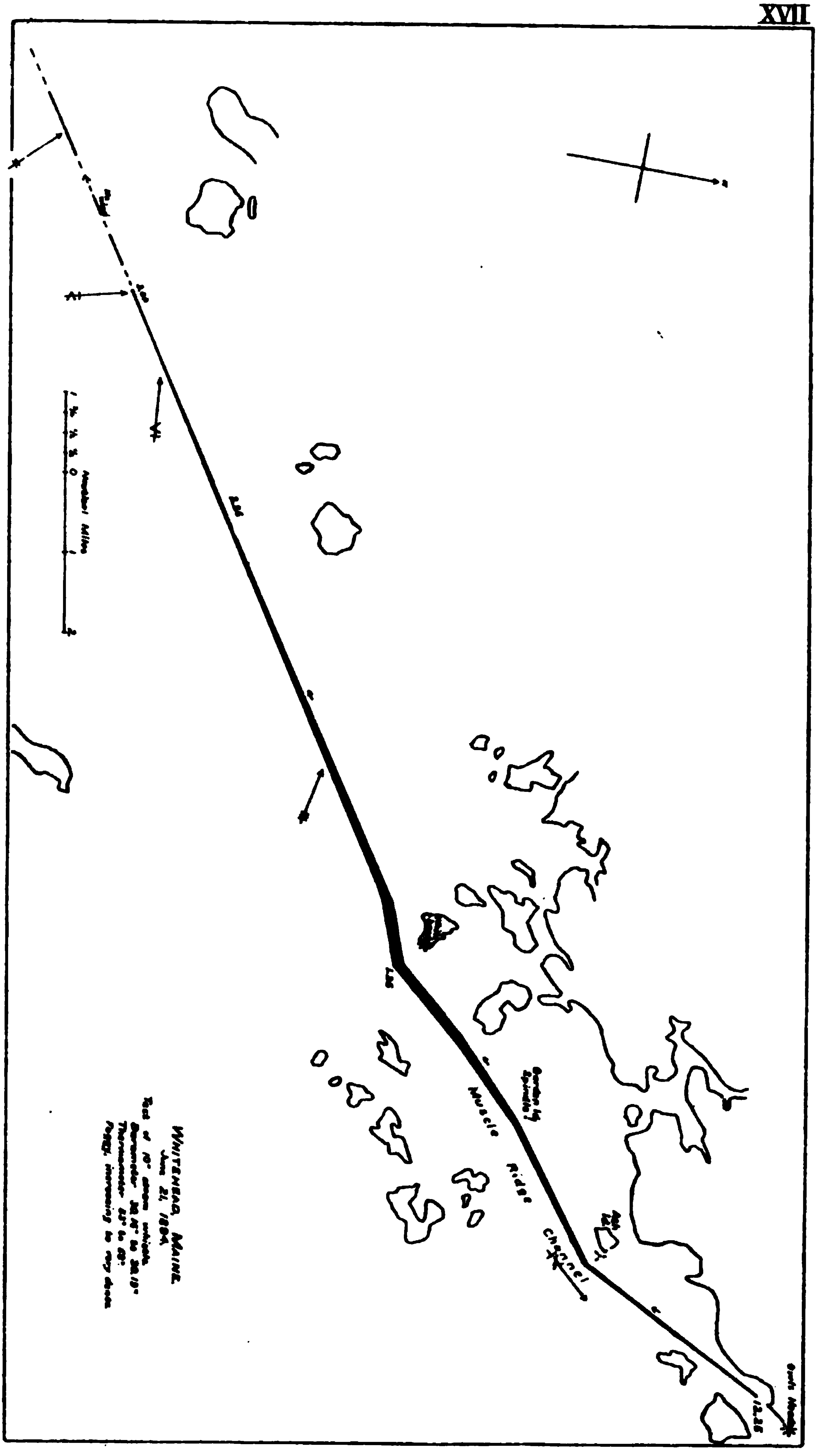

Portland
Peak's Island
Cushing Id
Portland Head Lt.
11.25
12.46
2.36
4.15
Cape Elizabeth Lts
No observations
3.28
N
Nautical Miles
CAPE ELIZABETH, ME.
Sept 11, 1893
Test of Siren
Barometer 30.3"
Thermometer 61°
Sky clear and blue, no clouds


Owls Head
12.00
Fisherman's Island
Muscle Ridge Channel
2.51
11.46
2.16
1.17
Tennant Harbor Light
12.50
Two Bush Id.
12.06
12.21
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Whitehead, Me.
Sept. 9, 1893 – 7 A.M. to 2 P.M.
Test of Fog Whistle.
Barometer 31.03"
Thermometer 49°
Sky ½ clear blue
½ white fleecy clouds.
Sea smooth. Waves 1" high.

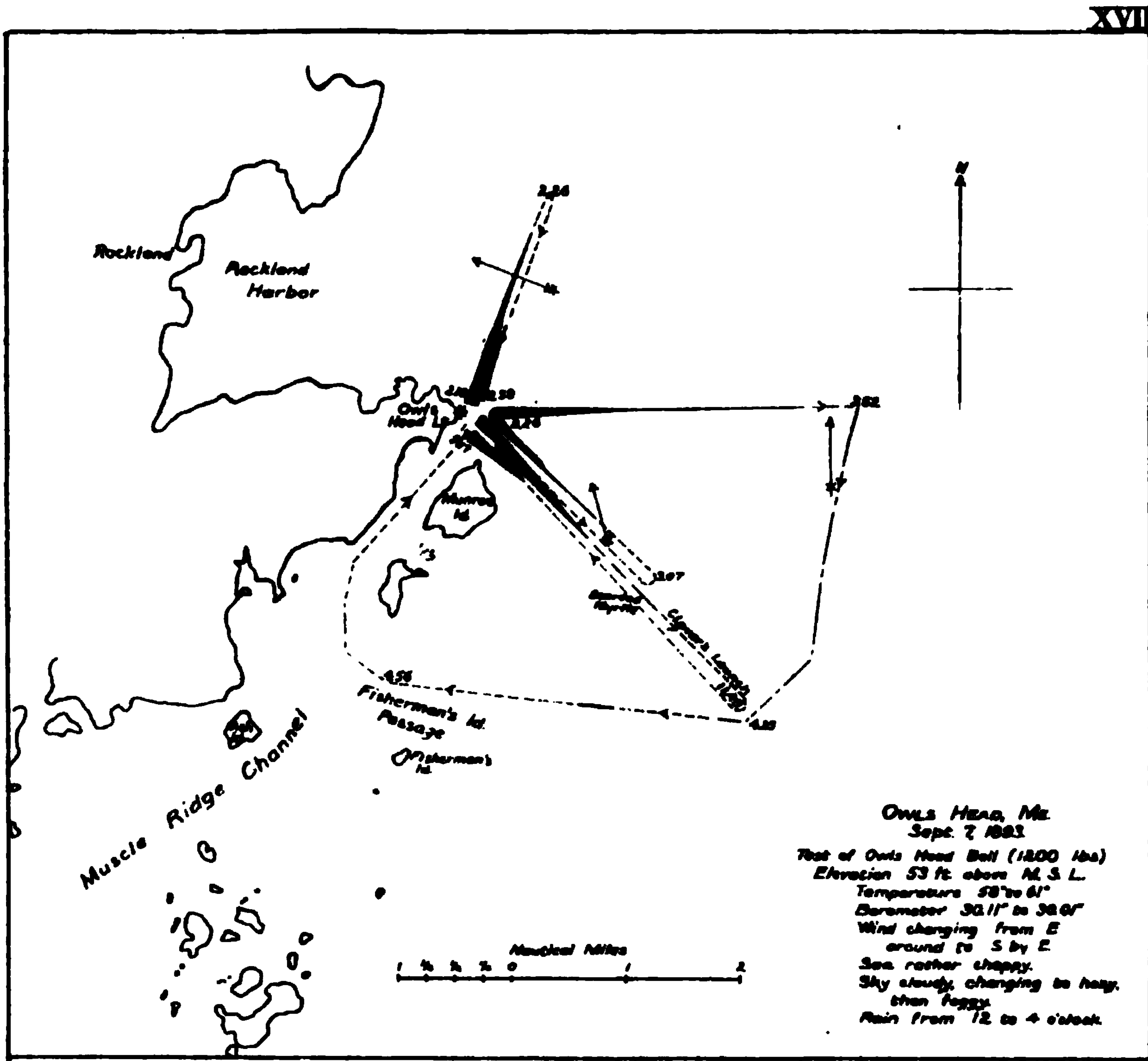

Tennant Harbor Light
2.05
3.51
4.34
4.03
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Whitehead, Me.
Sept. 9, 1893 – 2 P.M. to 6 P.M.
Test of Fog Whistle.
Barometer 31.8"
Thermometer 49°
Cloudiness ½.
Cirrus clouds in NE
Cirro-stratus in W
Wave heights 10"

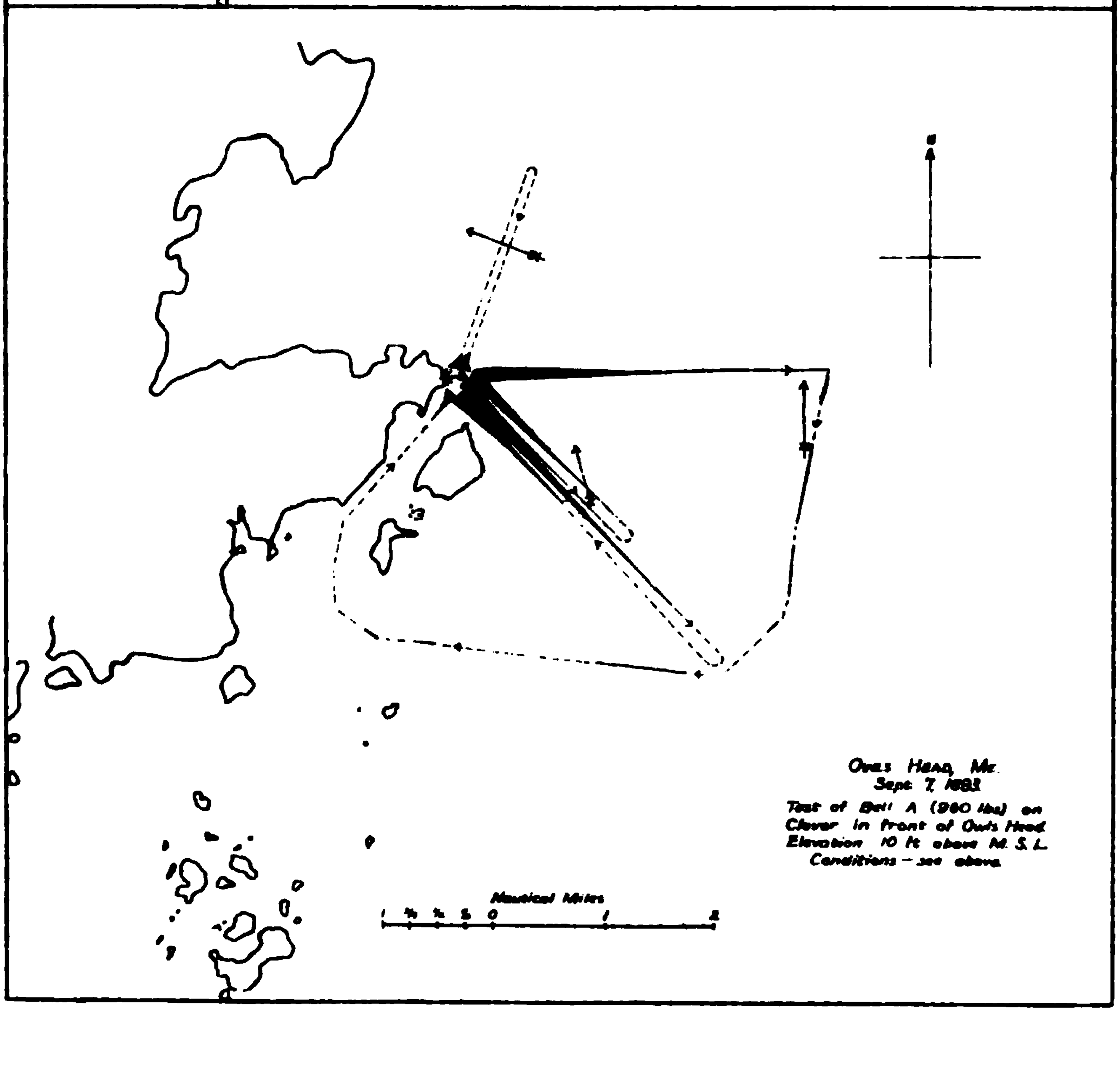

N
Seal Harbor
Otter Id
Nautical Miles
1 ¾ ½ ¼ 0 1 2
WHITEHEAD. ME
Sept. 28, 1893 - 7 to 11 A.M.
Test of 10" whistle
Barometer 30.13"
Thermometer 49°
Clouds and rain all morning
Rainfall 0.008" per hour
Sea choppy, waves 1 ft. high
● Myrtle's whistle and bell B on Myrtle heard at Whitehead

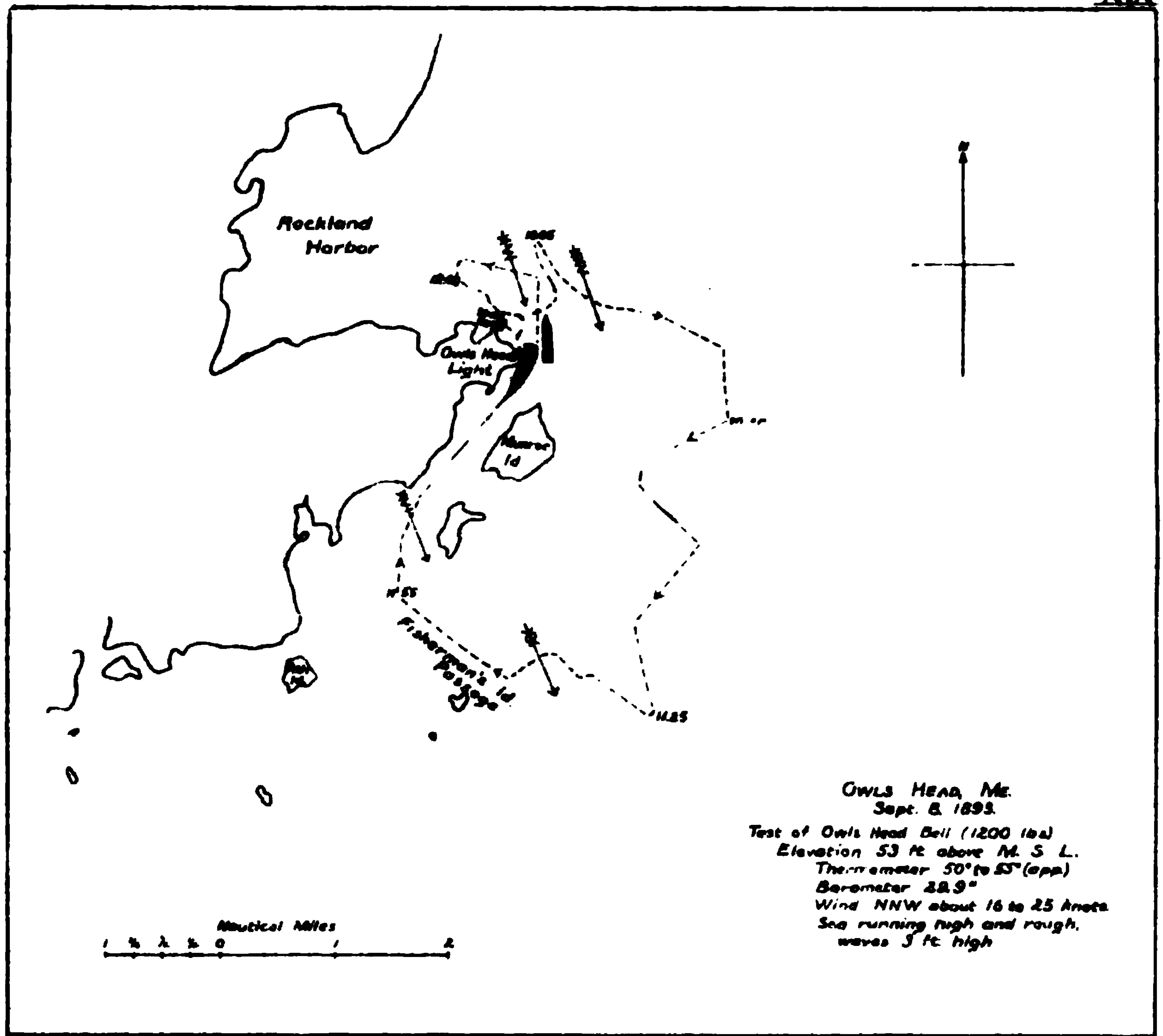

N
Owls Head
Otter Id
Nautical Miles
1 ¾ ½ ¼ 0 1 2
WHITEHEAD, ME.
Sept 28, 1893 - 11 A.M. to 5 P.M.
Test of 10" whistle.
Barometer 30.13 at noon
Thermometer (dry) 49° to 49.9°
(wet) 48.6° to 49.7°
Raining until 1 P.M.
Heavy mist all afternoon
Sea rough
O Bell B on Myrtle heard at Whitehead

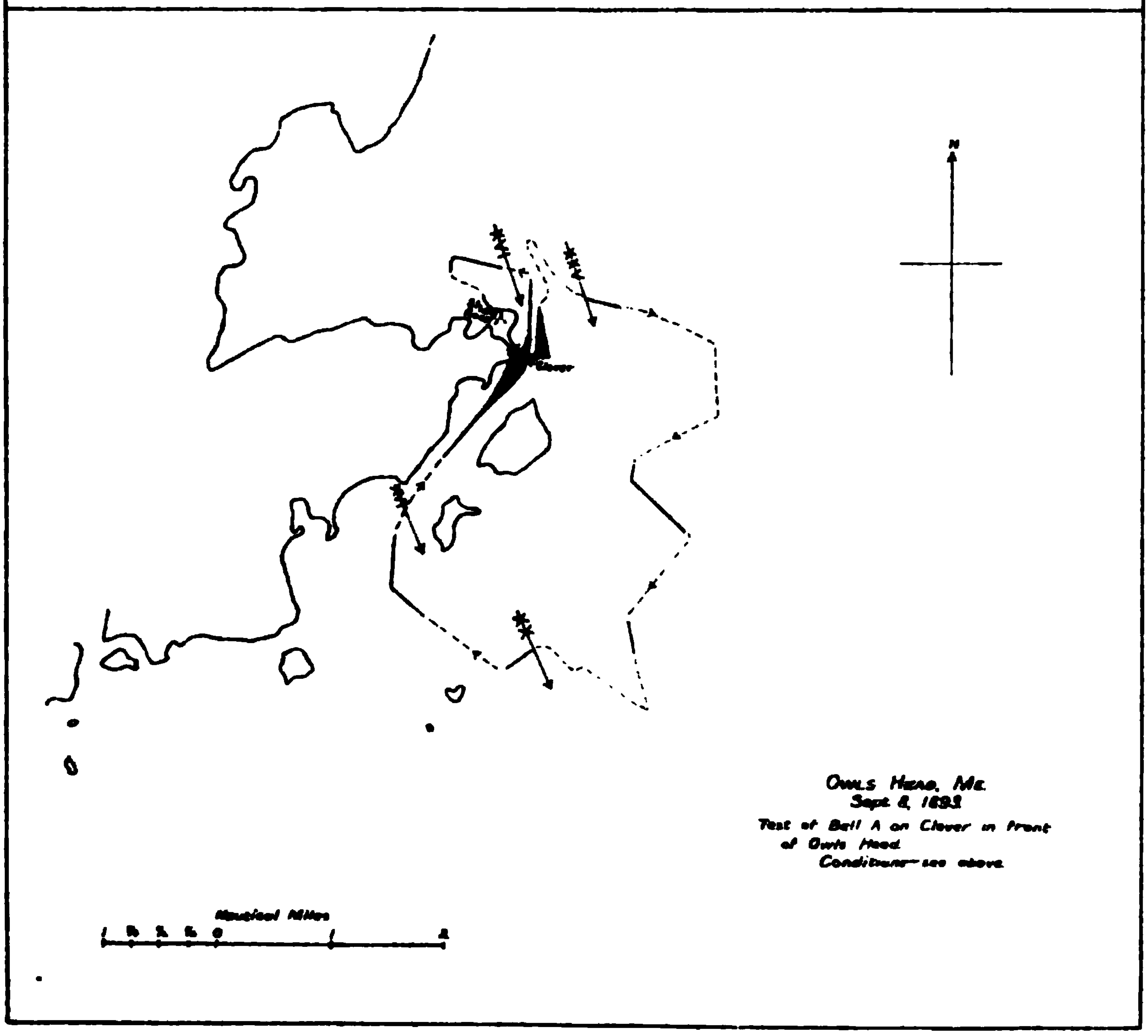

WHITEHEAD, MAINE.
Muscle Ridge Channel

XVIII

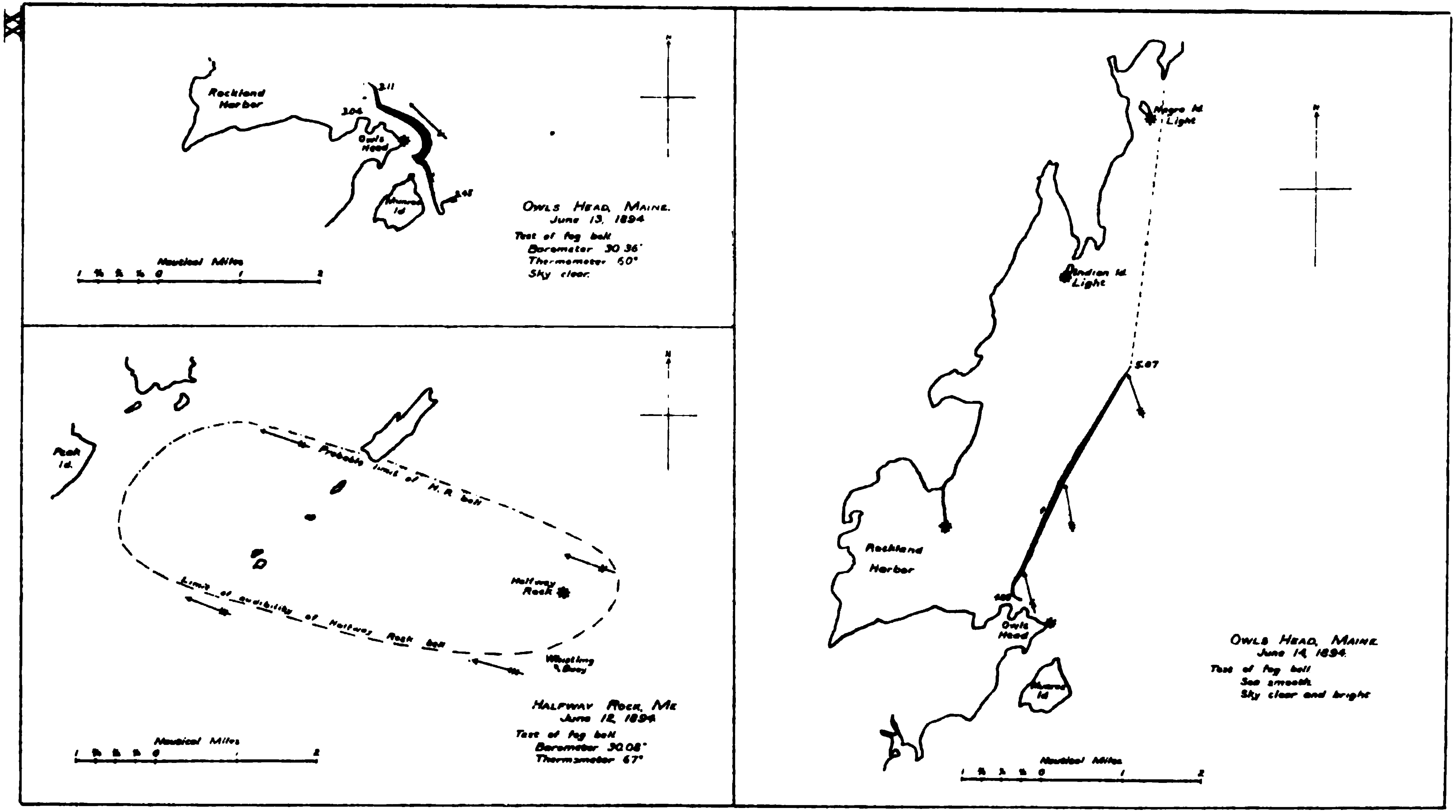

N
Rockland
Rockland Harbor
Monroe Id.
Fisherman's Id. Passage
Muscle Ridge Channel
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Owls Head, Me.
Sept. 7, 1893
Test of Owls Head Bell (1200 lbs)
Elevation 53 ft. above M. S. L.
Temperature 58° to 61°
Barometer 30.11" to 30.01"
Wind changing from E
around to S by E.
Sea rather choppy.
Sky cloudy, changing to hazy,
then foggy.
Rain from 12 to 4 o'clock.


N
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Owls Head, Me.
Sept. 7, 1893
Test of Bell A (900 lbs) on
Clover in front of Owls Head
Elevation 10 ft. above M. S. L.
Conditions — see above.

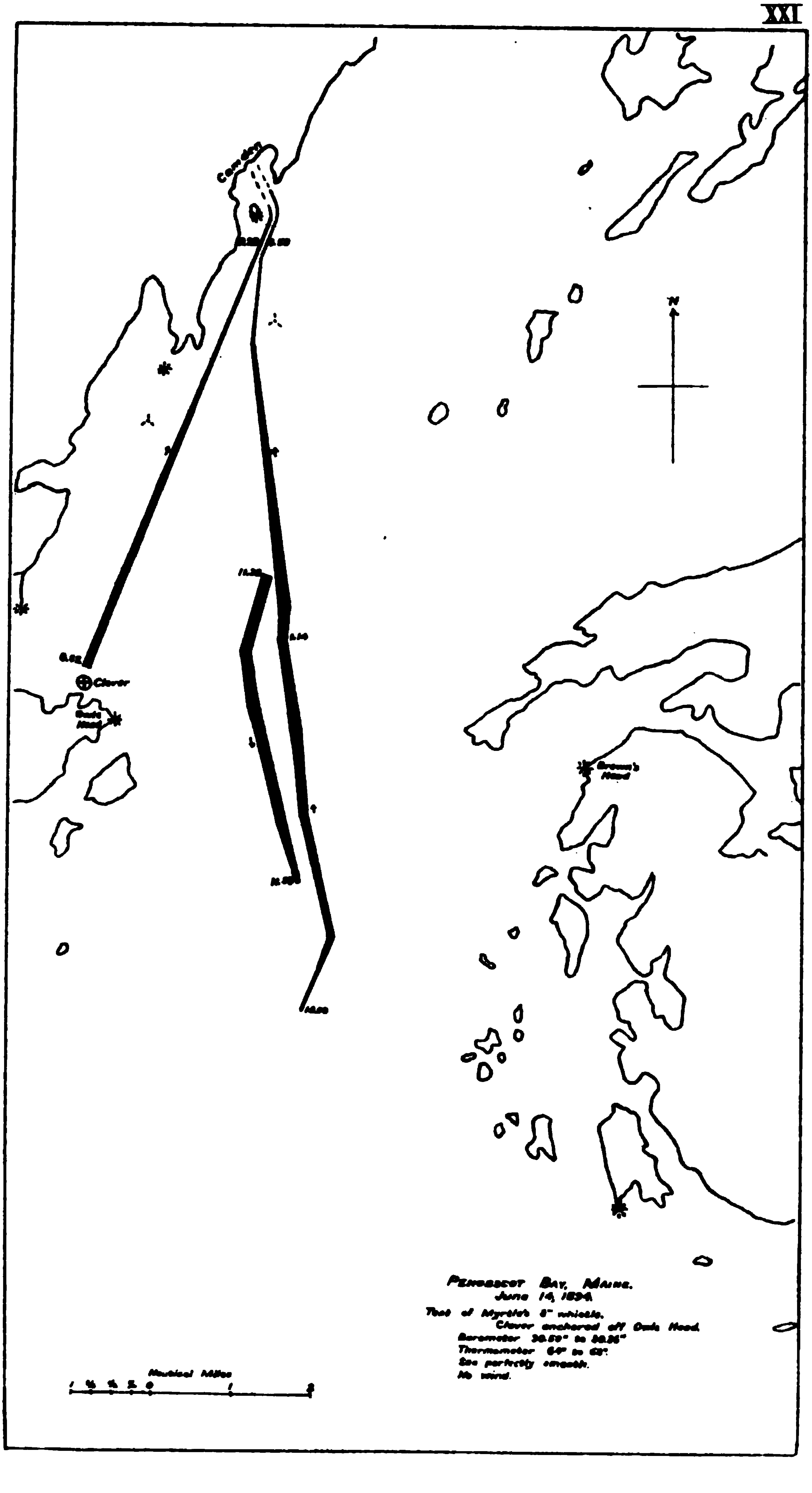

Rockland Harbor
Owls Head Light
Fisherman's Id Passage
Nautical Miles
Owls Head, Me.
Sept. 8, 1893.
Test of Owls Head Bell (1200 lbs)
Elevation 53 ft above M. S. L.
Thermometer 50° to 55° (app.)
Barometer 28.9"
Wind NNW about 16 to 25 knots
Sea running high and rough,
waves 3 ft high


Clover
Nautical Miles
Owls Head, Me.
Sept 8, 1893
Test of Bell A on Clover in front
of Owls Head
Conditions—see above

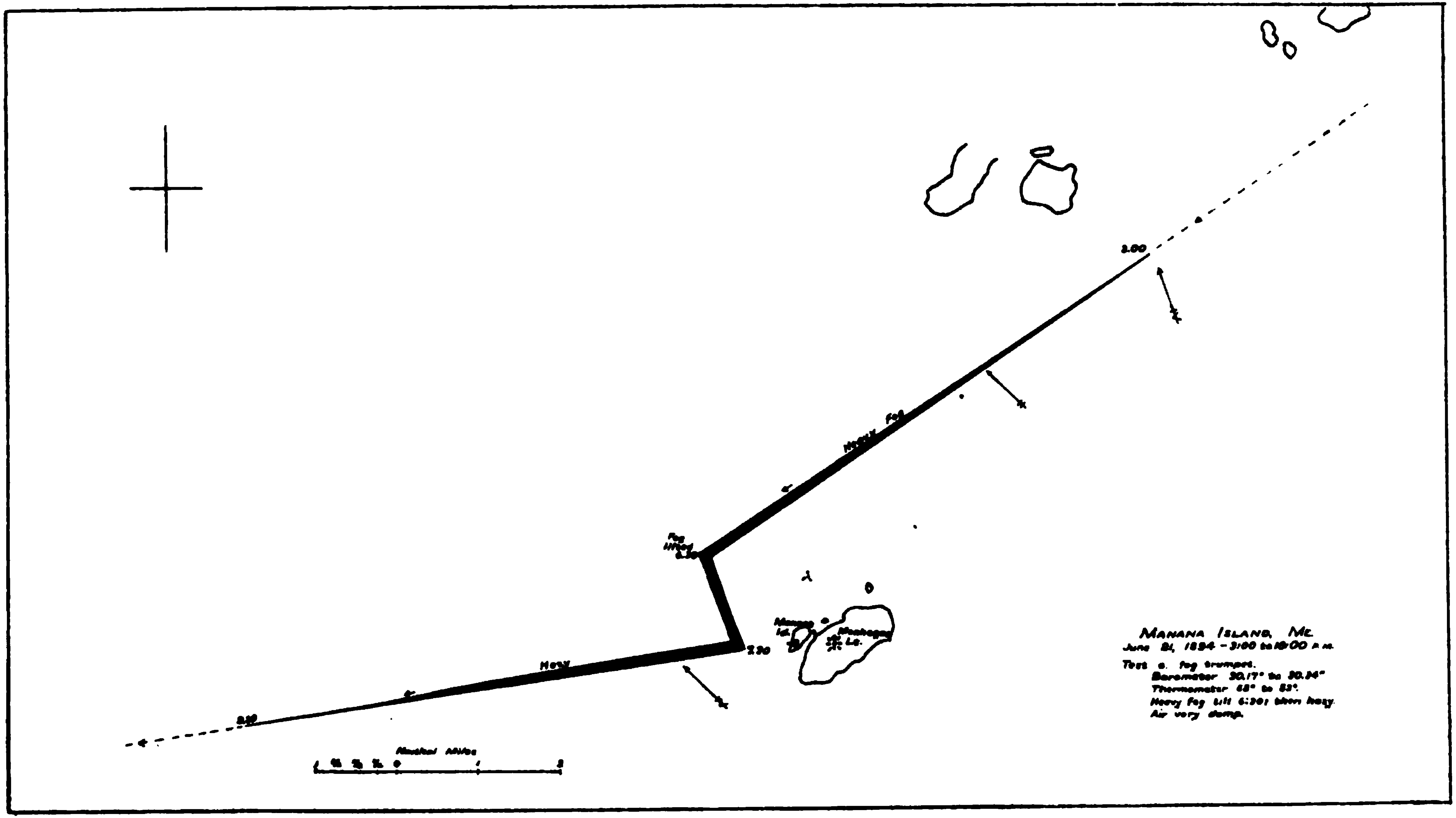
XX



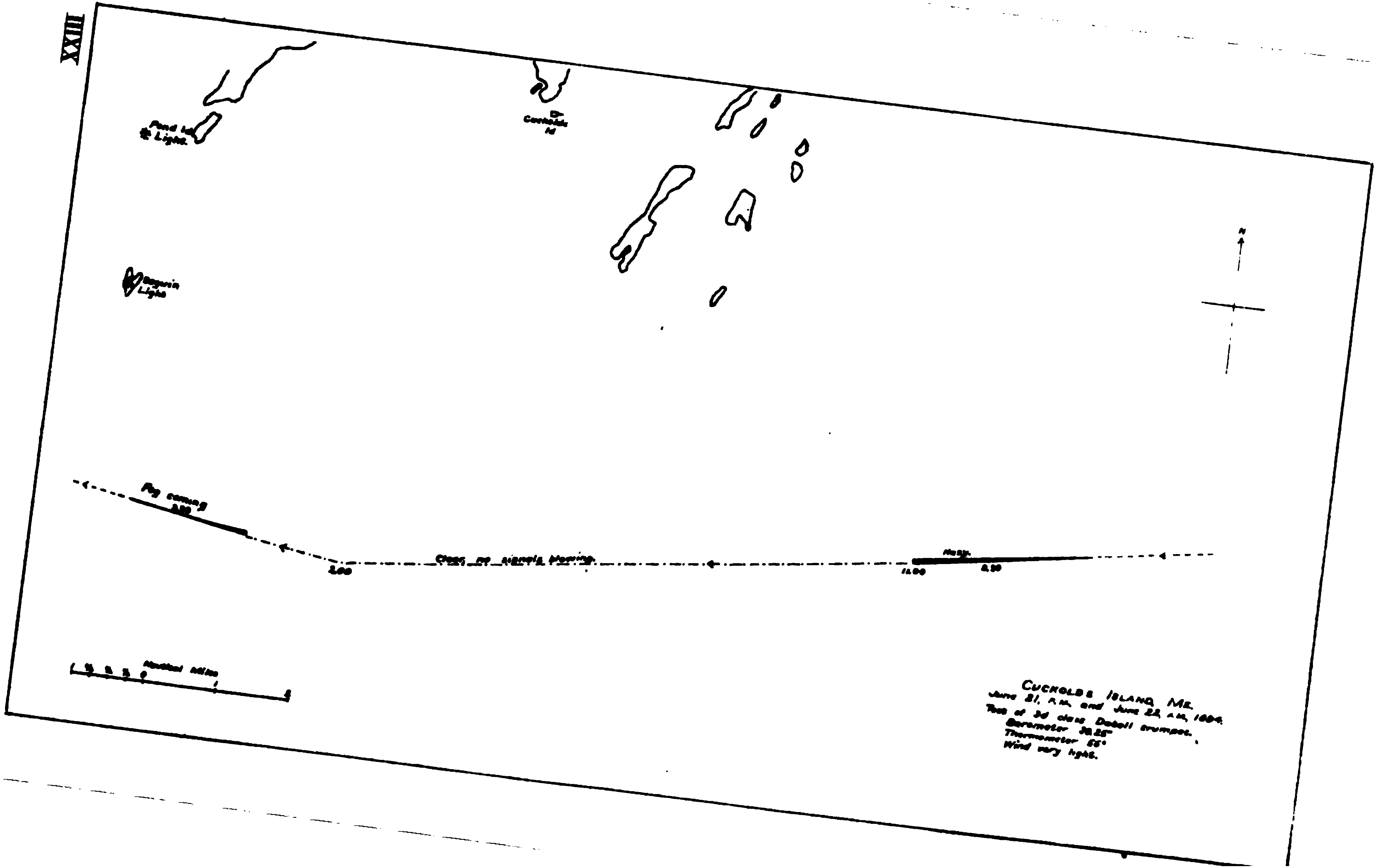
Rockland Harbor
Owls Head
Owls Head, Maine.
June 13, 1894
Test of fog bell
Barometer 30.36'
Thermometer 60°
Sky clear.
Nautical Miles
Peak Id.
Probable limit of H. R. bell
Limit of audibility of Halfway Rock bell
Halfway Rock
Whistling Buoy
Halfway Rock, Me
June 12, 1894
Test of fog bell
Barometer 30.08'
Thermometer 67°
Nautical Miles
Negro Id Light
Indian Id Light
5.07
Rockland Harbor
Owls Head
Owls Head, Maine.
June 14, 1894.
Test of fog bell
Sea smooth
Sky clear and bright
Nautical Miles


Camden
Clover
Owls Head
Brown's Head
Penobscot Bay, Maine.
June 14, 1894.
Clover anchored off Owls Head.
Sea perfectly smooth.
No wind.
Nautical Miles

XXII

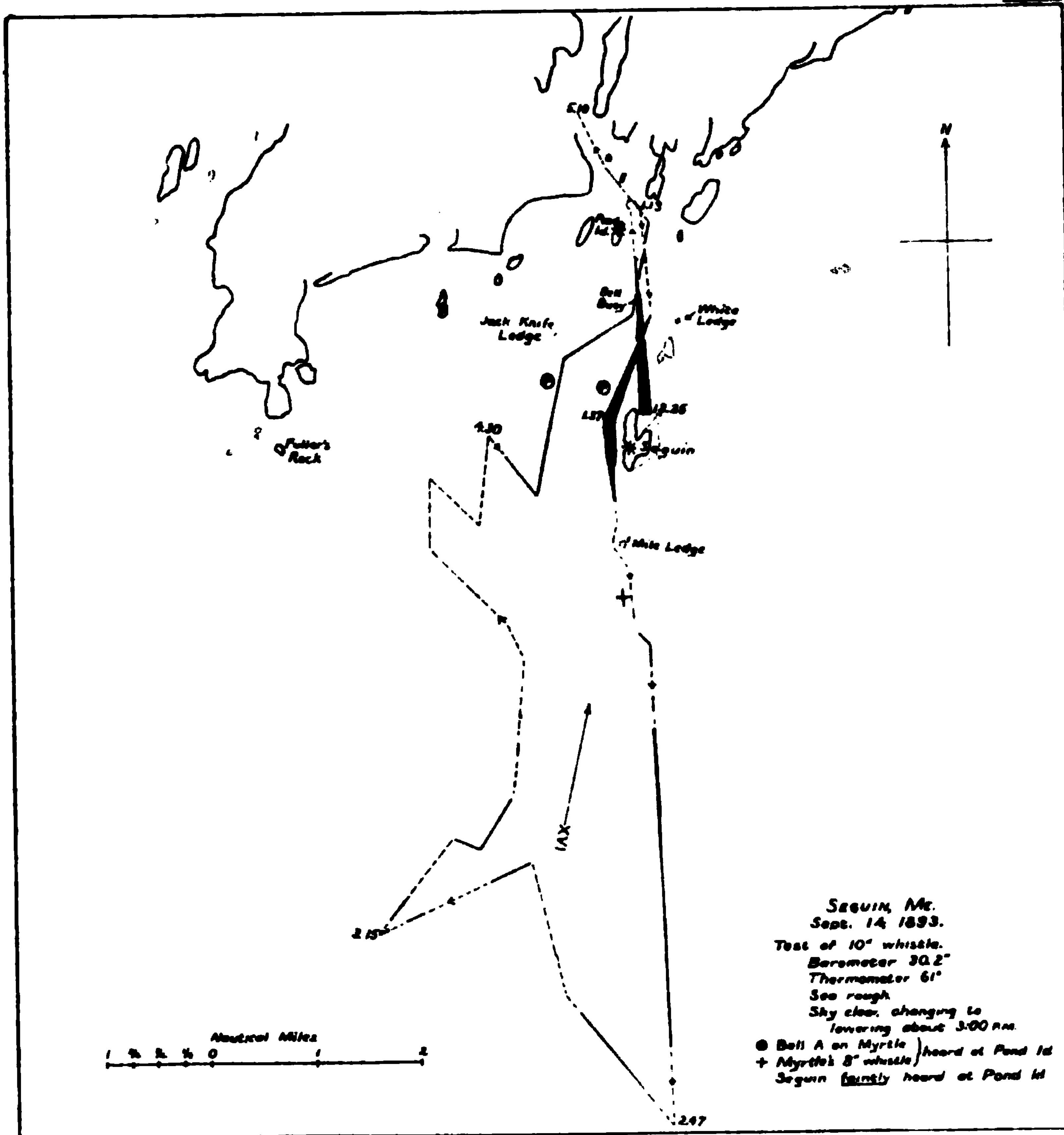

MANANA ISLAND, ME.
June 21, 1894 – 3:00 to 10:00 a. m.
Test a. fog trumpet.
Barometer 30.17" to 30.24"
Thermometer 68° to 83°.
Heavy fog till 6:30; then hazy.
Air very damp.
Heavy Fog
Fog lifted
Heavy
Nautical Miles
2.00

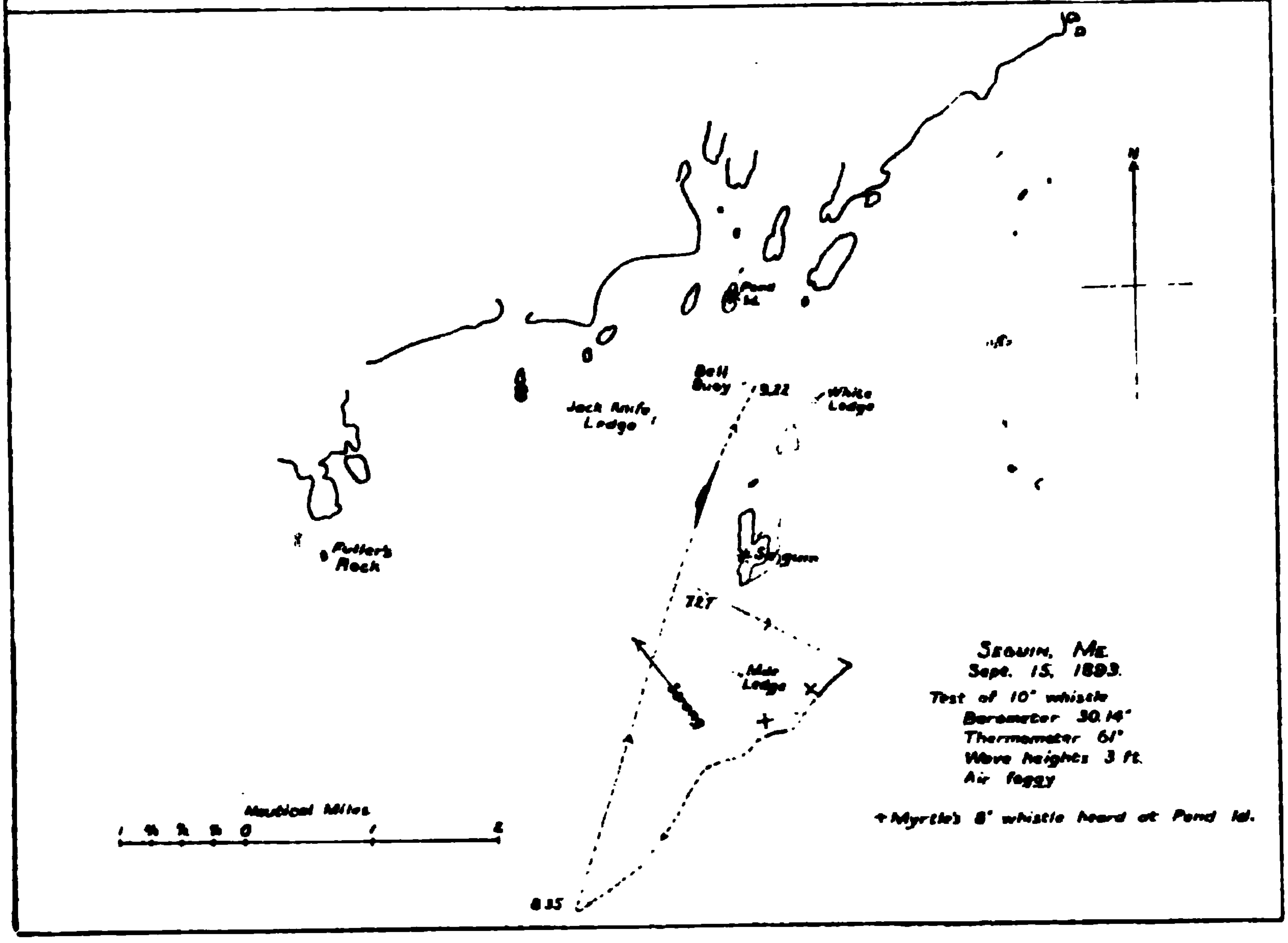
XXIII

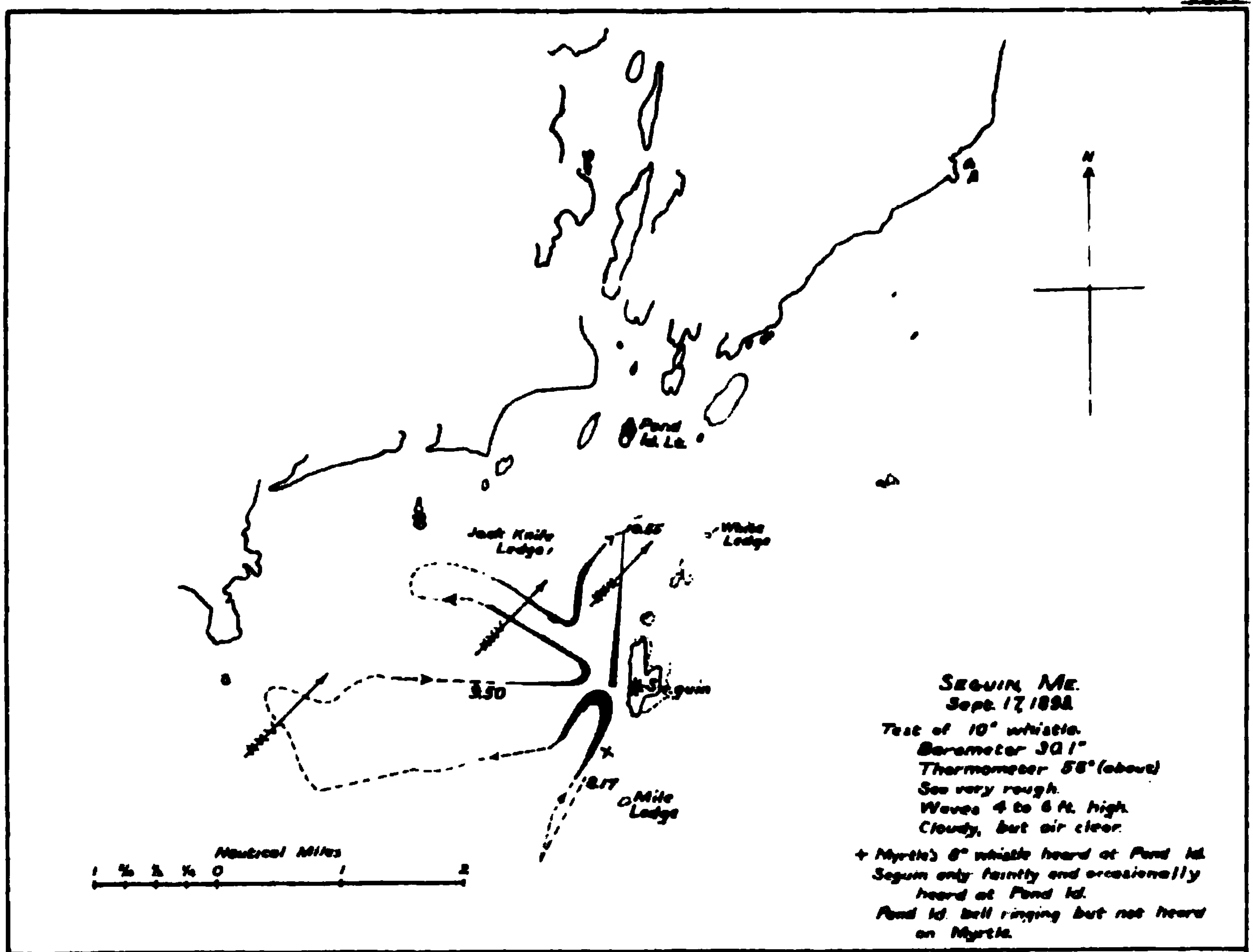


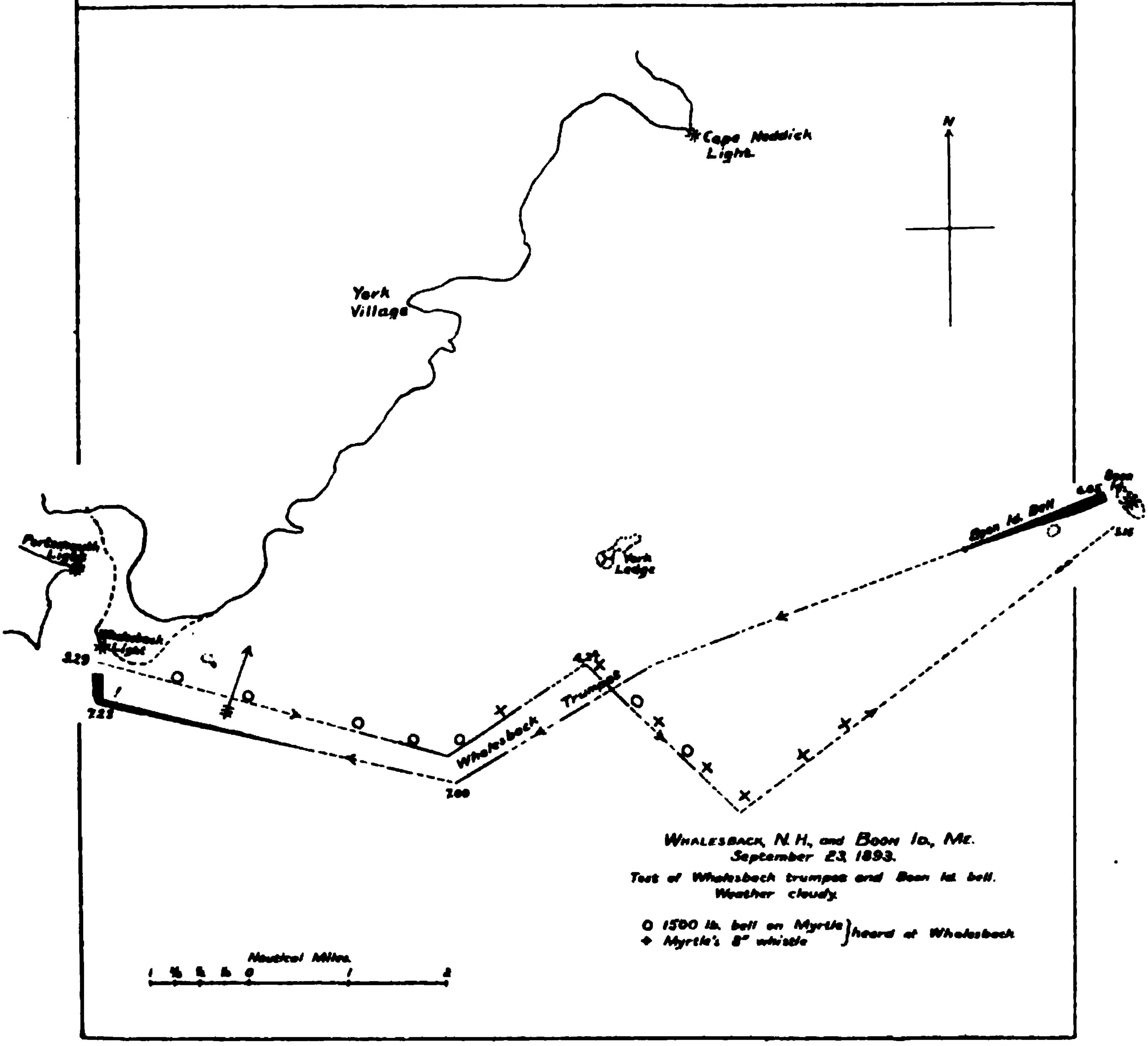
Pond Id.
Light.
Cuckolds Id.
Seguin Light
N
Fog coming
Clear, no signals blowing.
2.00
11.00
Hazy.
Nautical Miles
0
1
2
Cuckolds Island, Me.
June 21, P.M. and June 22, A.M. 1894.
Test of 3d class Daboll trumpet.
Barometer 30.25"
Thermometer 55°
Wind very light.

XXIV

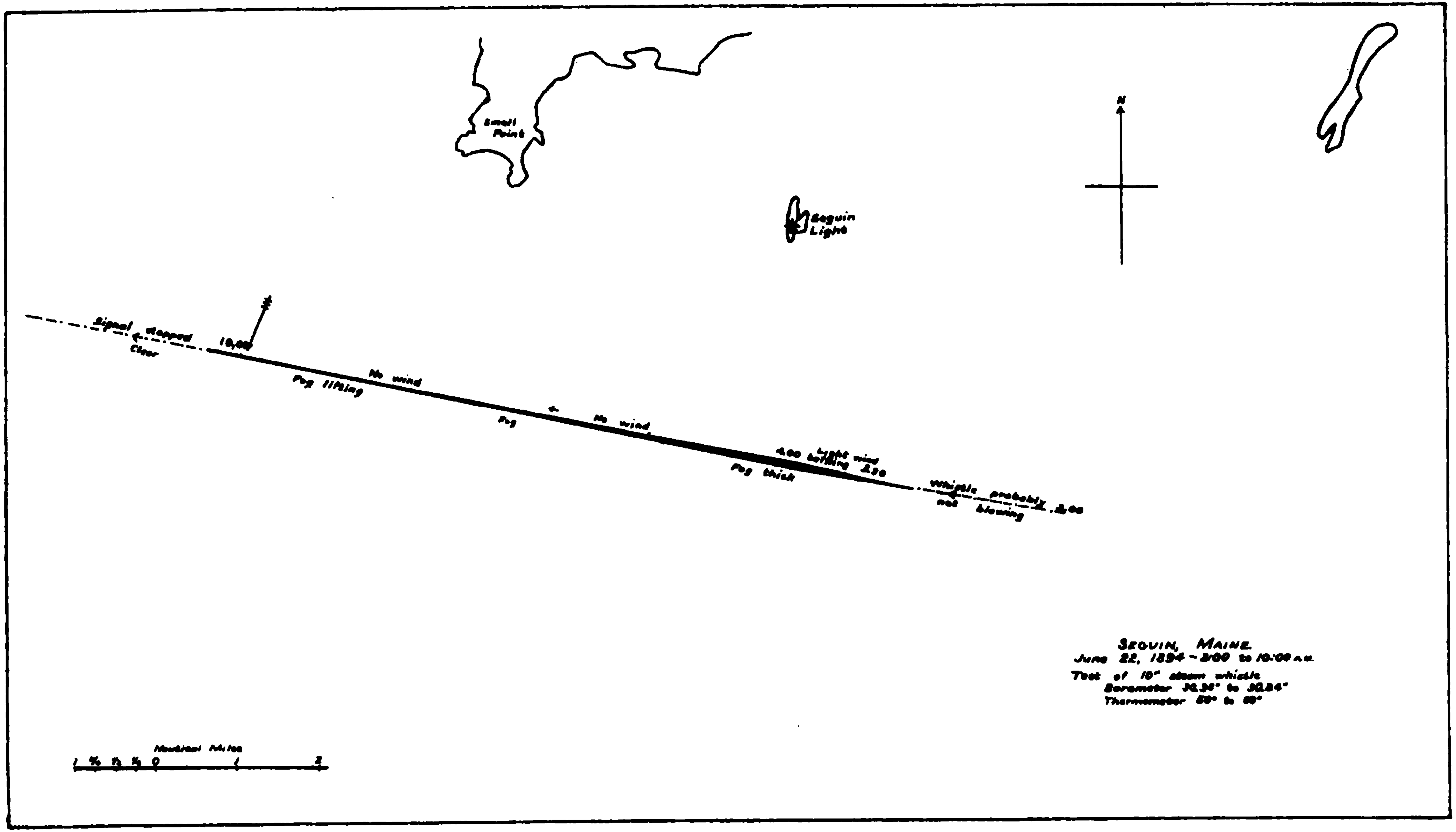

N
Pond Id.
Bell Buoy
White Ledge
Jack Knife Ledge
Fuller's Rock
Seguin
Mile Ledge
Nautical Miles
Seguin, Me.
Sept. 14, 1893.
Test of 10" whistle.
Barometer 30.2"
Thermometer 61°
Sea rough.
Sky clear, changing to lowering about 3:00 P.M.
● Bell A on Myrtle
+ Myrtle's 8" whistle
heard at Pond Id.
Seguin faintly heard at Pond Id.

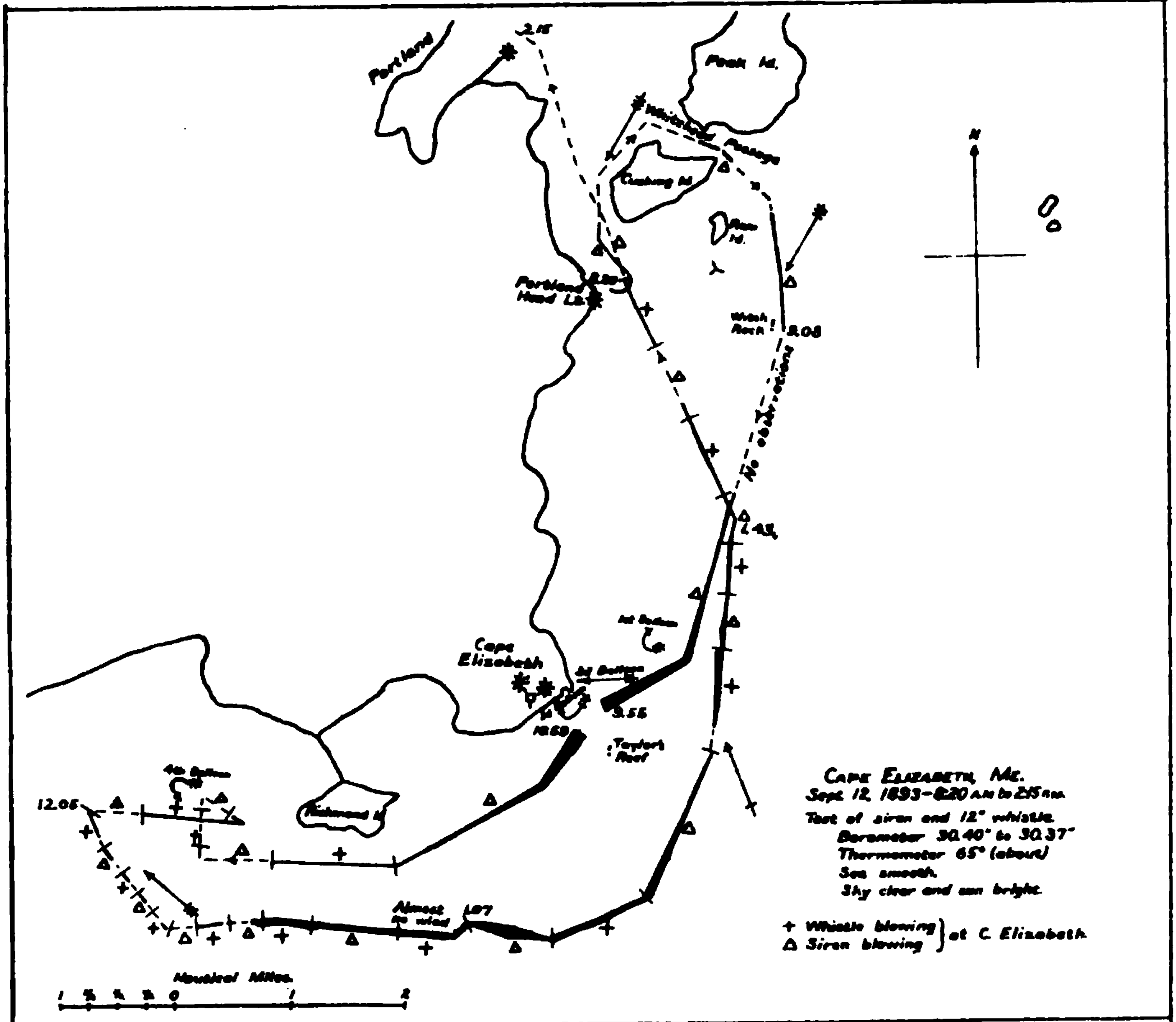

N
Pond Id.
Bell Buoy
White Ledge
Jack Knife Ledge
Fuller's Rock
Seguin
Mile Ledge
Nautical Miles
Seguin, Me.
Sept. 15, 1893.
Test of 10" whistle
Barometer 30.14"
Thermometer 61°
Wave heights 3 ft.
Air foggy
+ Myrtle's 8" whistle heard at Pond Id.

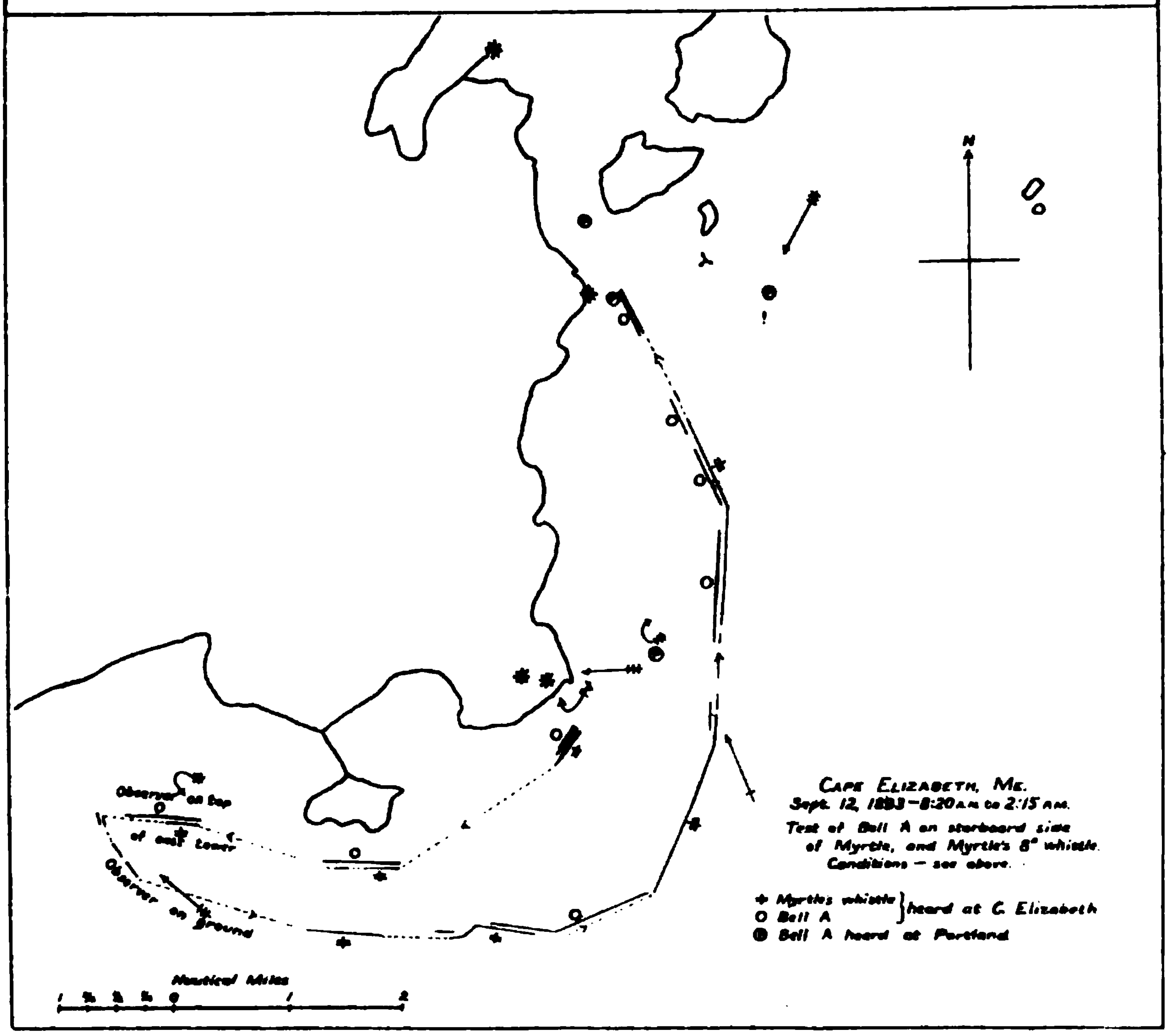

N
Pond Id. Le.
Jack Knife Ledge
White Ledge
10.55
3.50
Seguin
8.17
Mile Ledge
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Seguin, Me.
Sept. 17, 1893.
Test of 10" whistle.
Barometer 30.1"
Thermometer 58° (about)
Sea very rough.
Waves 4 to 6 ft. high.
Cloudy, but air clear.
+ Myrtle's 8" whistle heard at Pond Id.
Seguin only faintly and occasionally heard at Pond Id.
Pond Id. bell ringing but not heard on Myrtle.

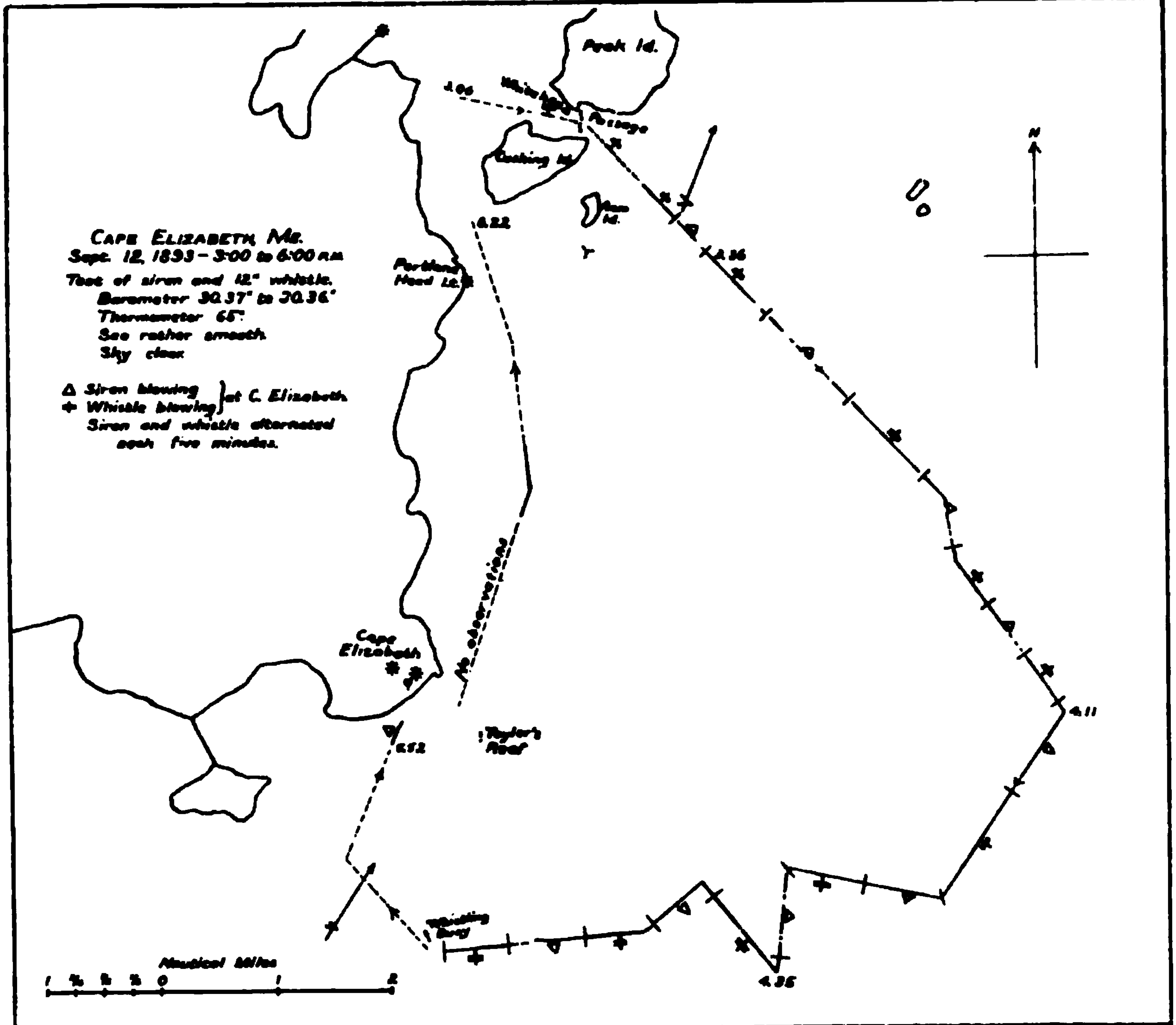

N
Cape Neddick Light
York Village
Portsmouth Light
Whaleback Light
York Ledge
Boon Id. Bell
Boon Id.
3.29
2.23
2.00
4.24
Whaleback
Whaleback Trumpet
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Whaleback, N.H., and Boon Id., Me.
September 23, 1893.
Test of Whaleback trumpet and Boon Id. bell.
Weather cloudy.
O 1500 lb. bell on Myrtle
+ Myrtle's 8" whistle
heard at Whaleback

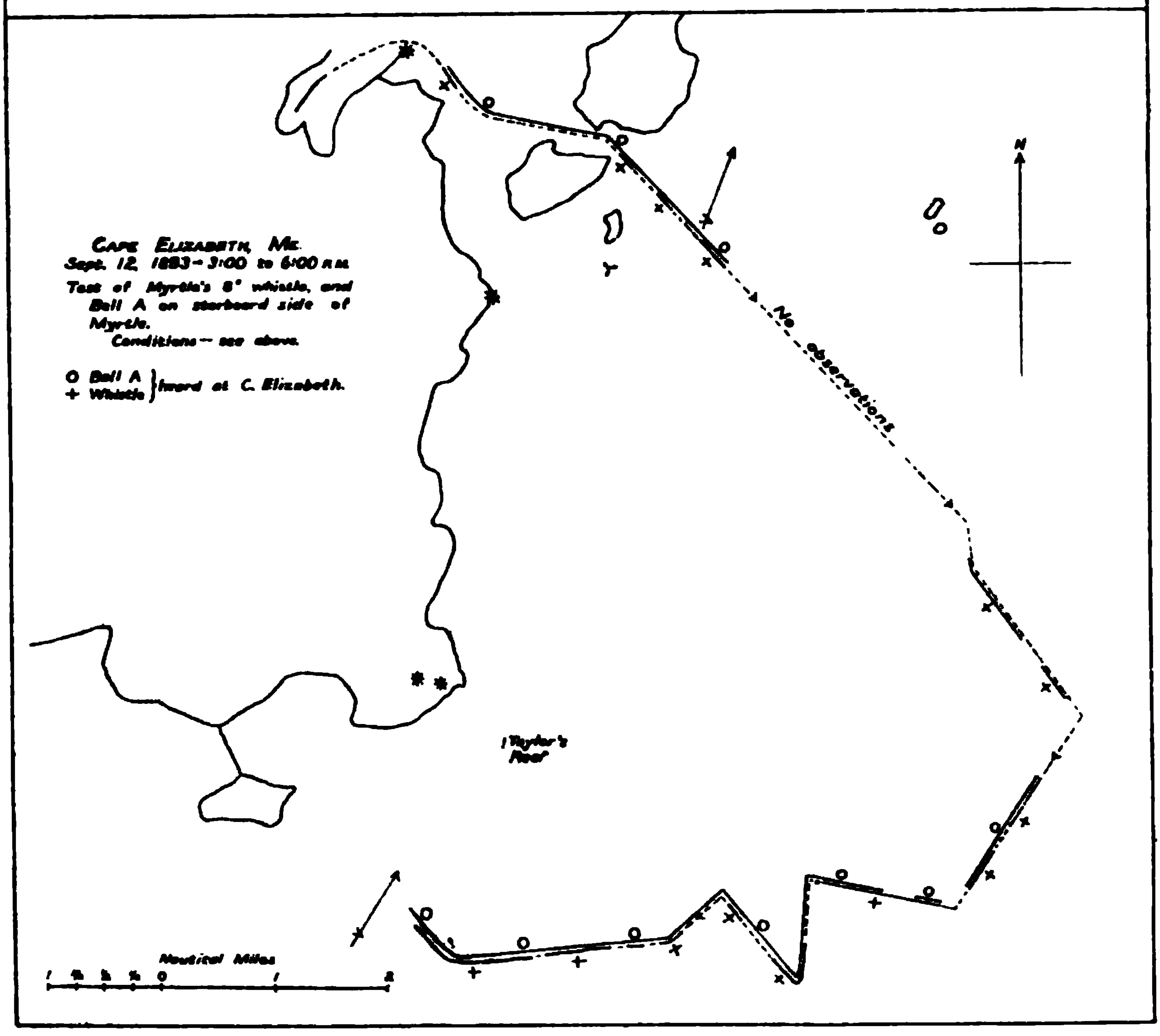
XXVI

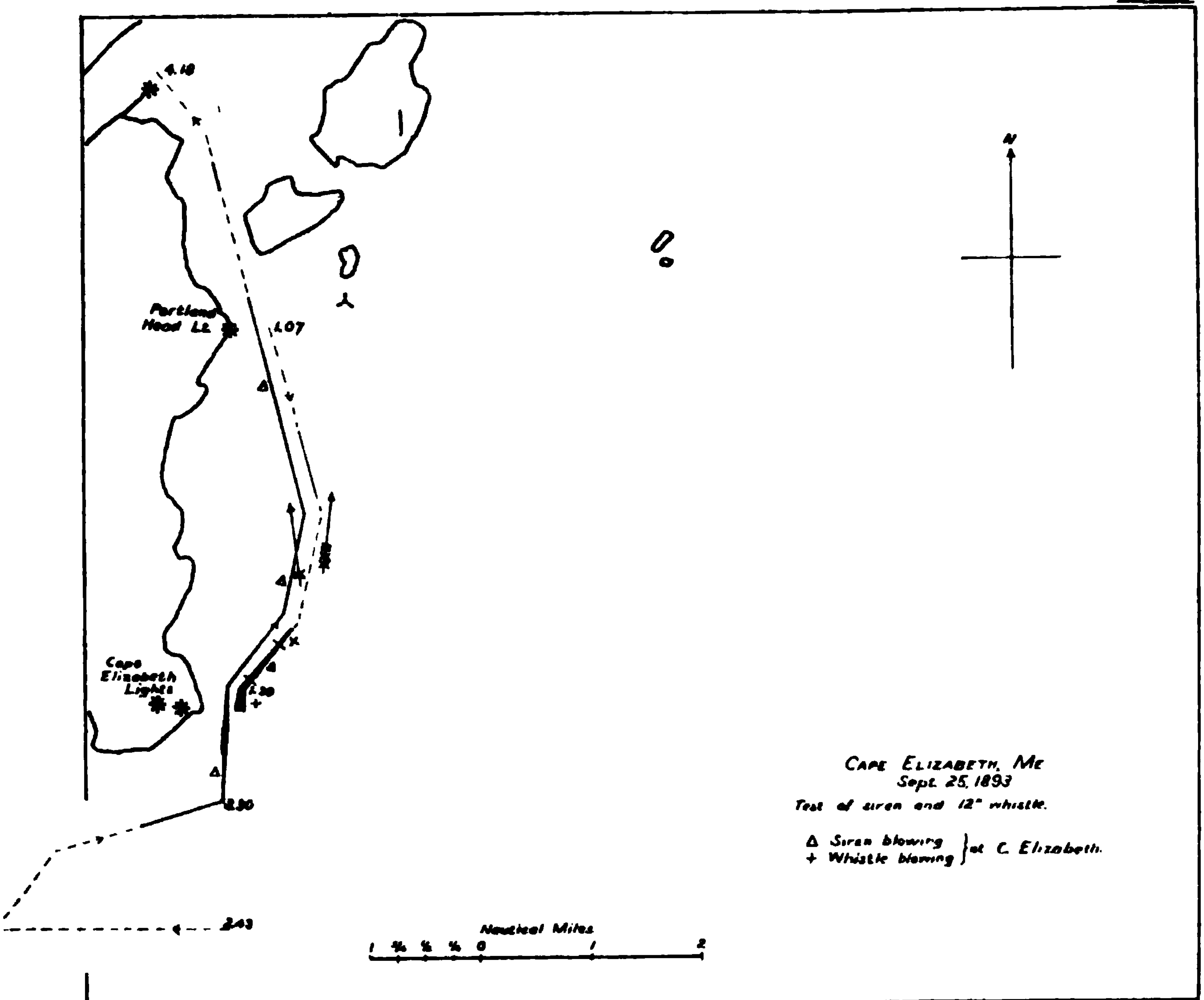

Small Point
Seguin Light
N
Signal stopped
Clear
10.00
No wind
Fog lifting
Fog
No wind
Light wind
4.00 baffling 2.30
Fog thick
Whistle probably
not blowing
2.00
Nautical Miles
1 ¾ ½ ¼ 0 1 2
SEGUIN, MAINE.
June 22, 1894 – 3:00 to 10:00 A.M.
Test of 10" steam whistle
Barometer 30.34" to 30.24"
Thermometer

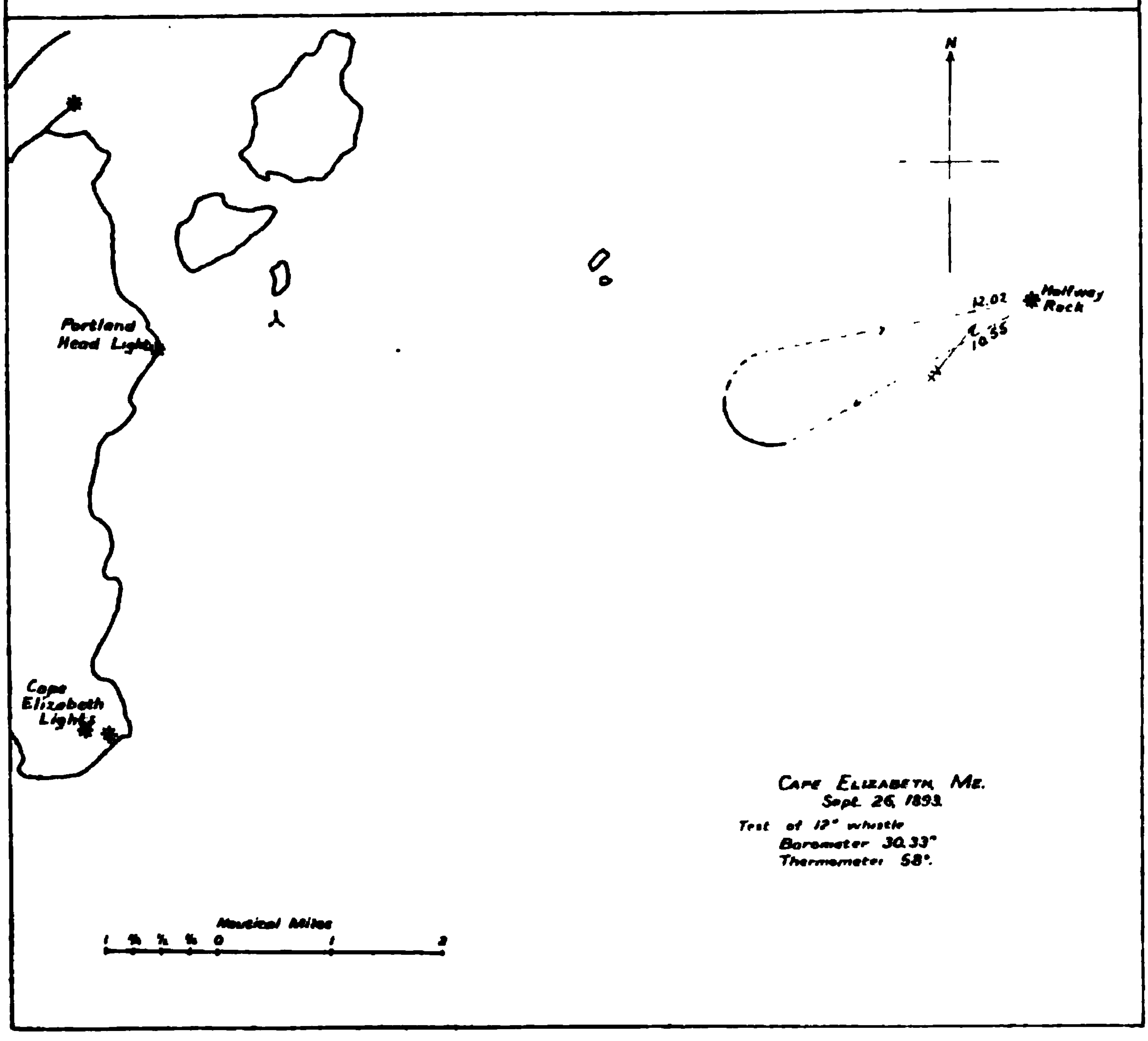

Portland
2.15
Peak Id.
Whitehead Passage
Cushing Id.
Ram Id.
Portland Head Lt.
8.30
Witch Rock
8.08
No observations
1.43
N
1st Bottom
Cape Elizabeth
2d Bottom
3.56
1868
Taylor's Reef
4th Bottom
12.05
Richmond Id.
Almost no wind
1.07
Cape Elizabeth, Me.
Sept. 12, 1893 – 8:20 A.M. to 2:15 P.M.
Test of siren and 12" whistle.
Barometer 30.40" to 30.37"
Thermometer 65° (about)
Sea smooth.
Sky clear and sun bright.
+ Whistle blowing
△ Siren blowing
at C. Elizabeth
Nautical Miles
1 ¾ ½ ¼ 0 1 2

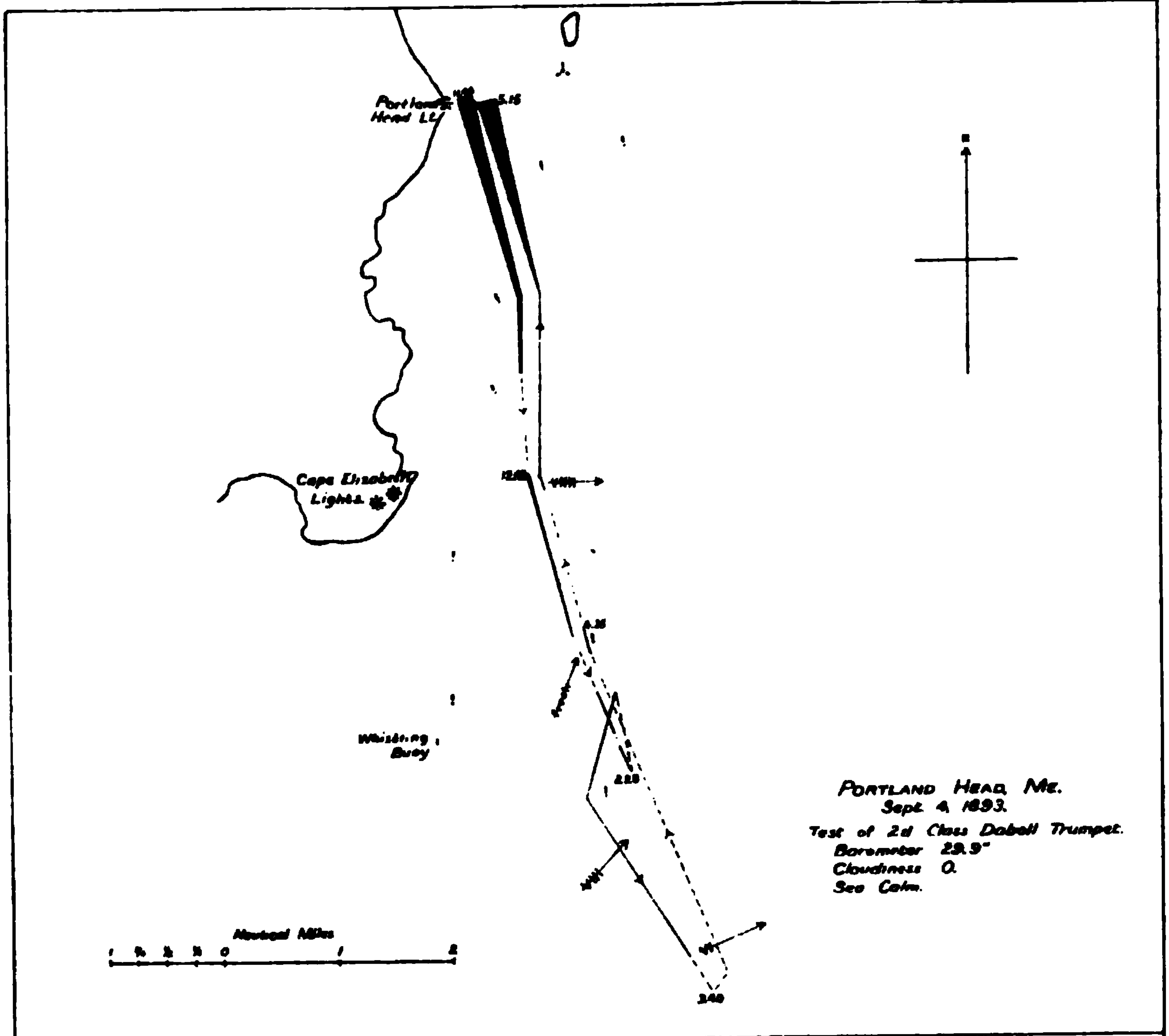

N
Observer on top of east tower
Observer on ground
Cape Elizabeth, Me.
Sept. 12, 1893 – 8:20 A.M. to 2:15 P.M.
Test of Bell A on starboard side of Myrtle, and Myrtle's 8" whistle.
Conditions – see above.
Myrtle's whistle
Bell A
heard at C. Elizabeth
Bell A heard at Portland
Nautical Miles
1 ¾ ½ ¼ 0 1 2

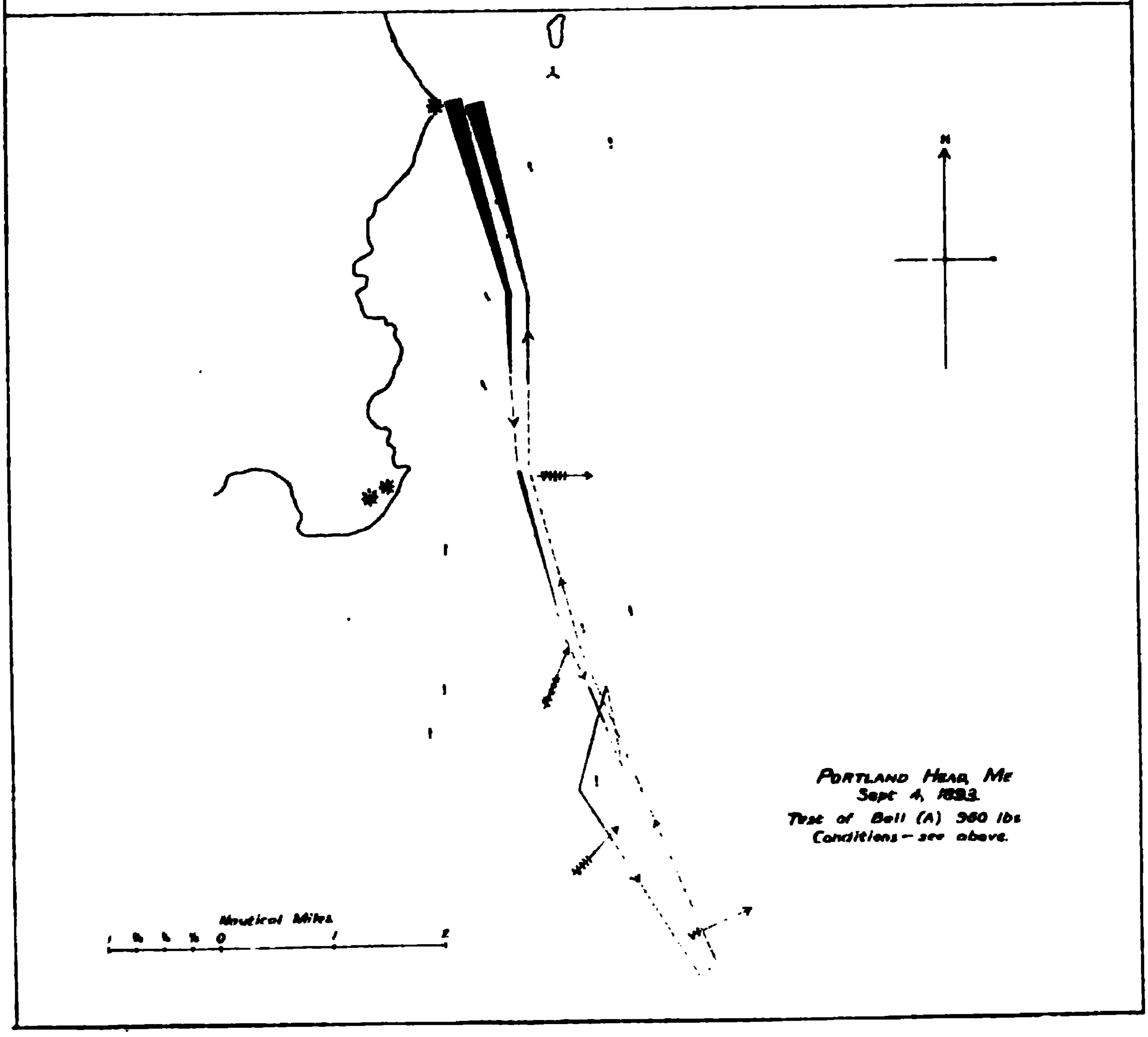

Cape Elizabeth, Me.
Sept. 12, 1893 – 3:00 to 6:00 P.M.
Test of siren and 12" whistle.
Barometer 30.37" to 30.36"
Thermometer 65°.
Sea rather smooth.
Sky clear.
△ Siren blowing } at C. Elizabeth.
✛ Whistle blowing
Siren and whistle alternated each five minutes.
Peak Id.
Passage
Cushing Id.
Portland Head Lt.
Cape Elizabeth
No observations
Taylor's Reef
Whistling Buoy
Nautical Miles
N

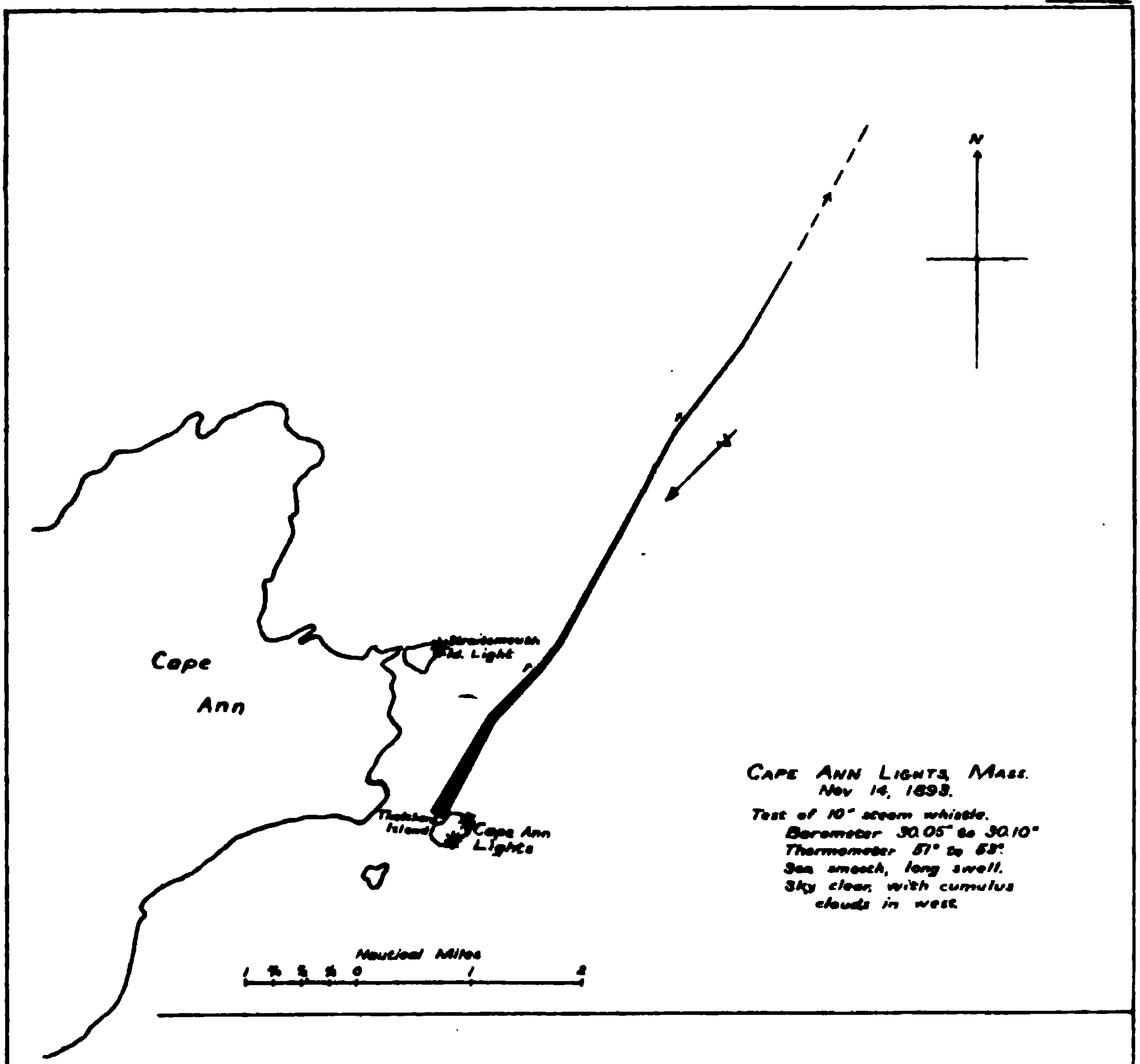

Cape Elizabeth, Me.
Sept. 12, 1893 – 3:00 to 6:00 P.M.
Test of Myrtle's 8" whistle, and Bell A on starboard side of Myrtle.
Conditions — see above.
○ Bell A } heard at C. Elizabeth.
+ Whistle
No observations
Taylor's Reef
Nautical Miles
N

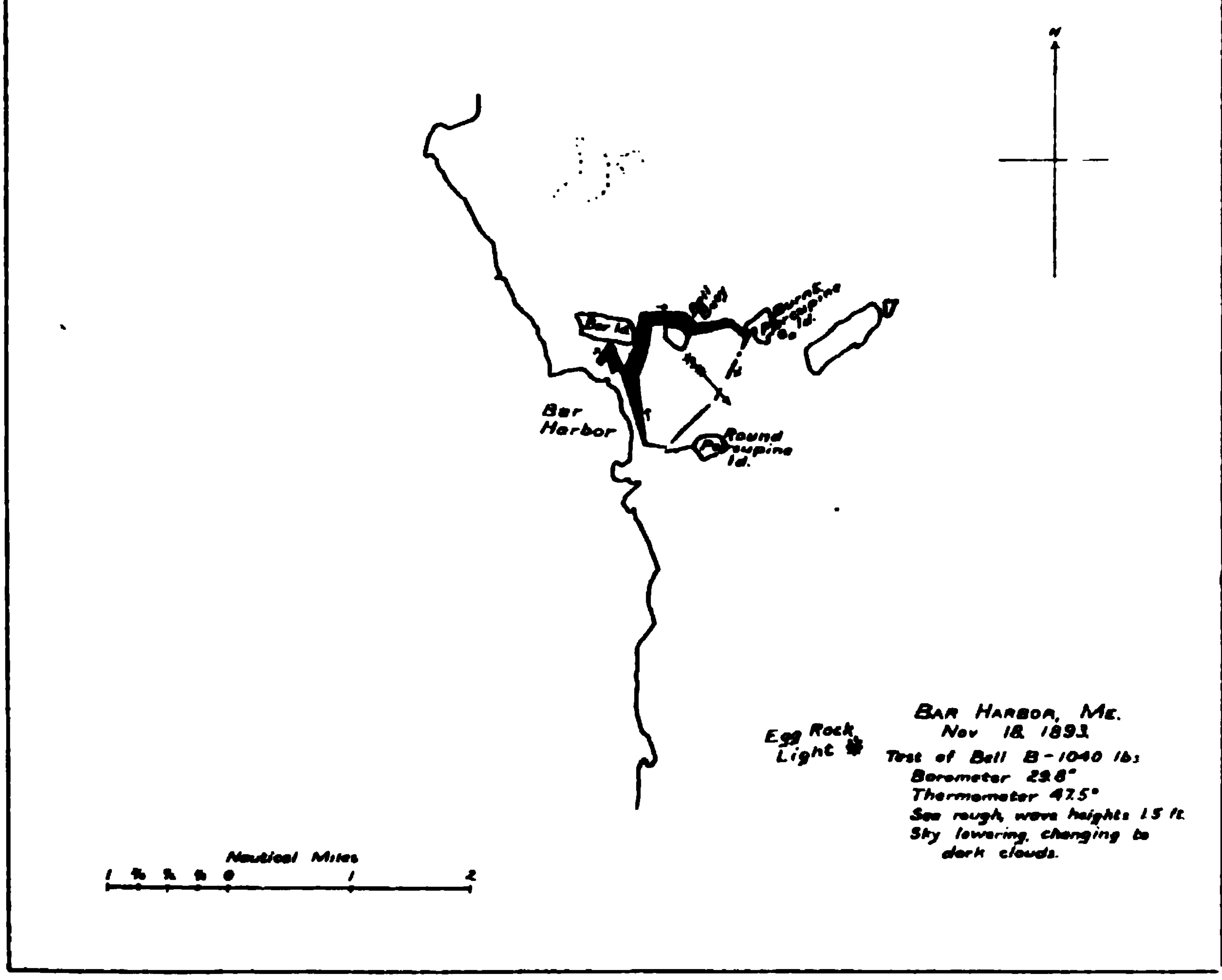

4.18
N
Portland Head Lt.
1.07
Cape Elizabeth Lights
2.43
Cape Elizabeth, Me
Sept. 25, 1893
Test of siren and 12" whistle.
Δ Siren blowing
+ Whistle blowing
at C. Elizabeth.
Nautical Miles
1 3/4 1/2 1/4 0 1 2

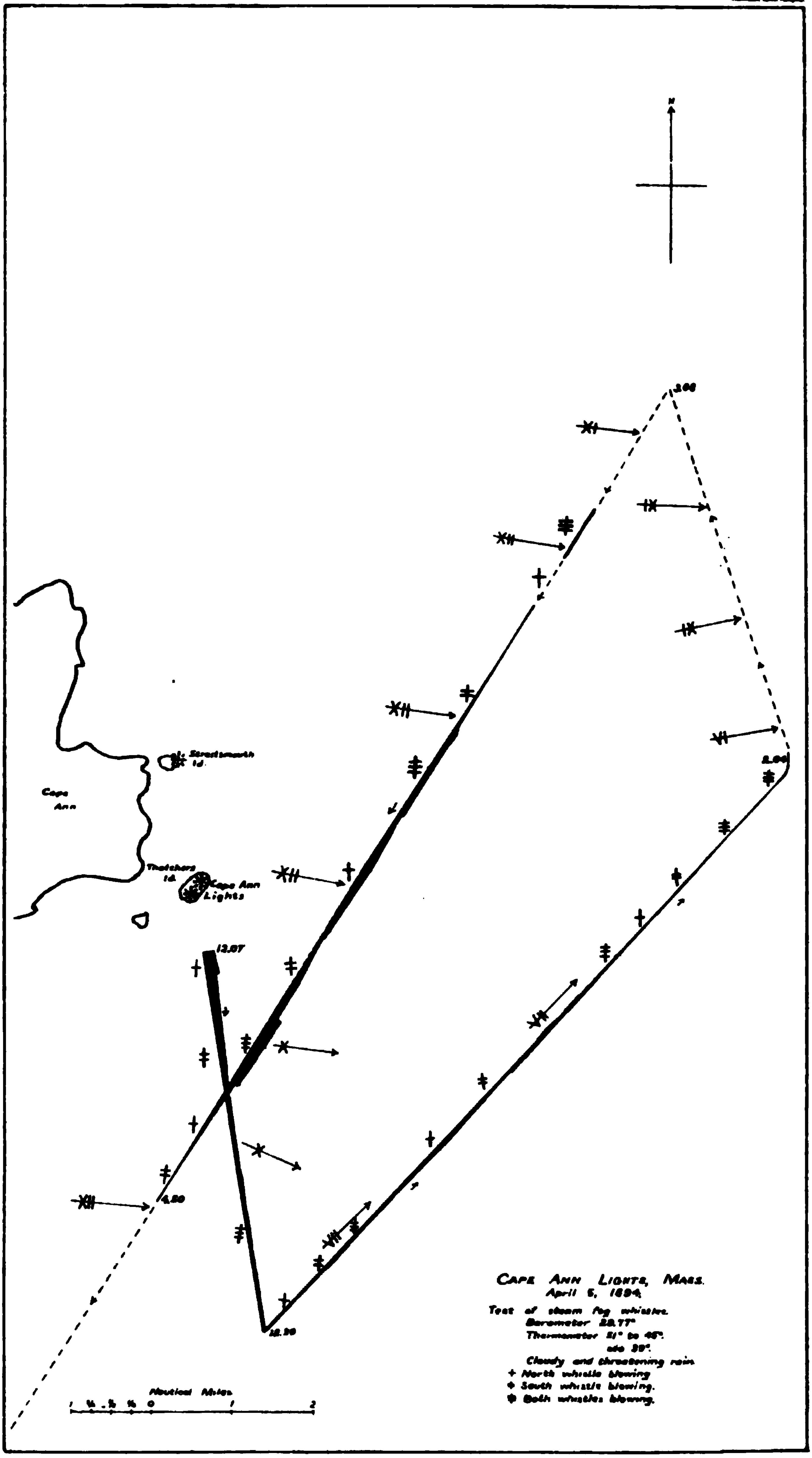

N
12.02
Halfway Rock
10.55
Portland Head Light
Cape Elizabeth Lights
Cape Elizabeth, Me.
Sept. 26, 1893.
Test of 12" whistle
Barometer 30.33"
Thermometer 58°.
Nautical Miles
1 3/4 1/2 1/4 0 1 2

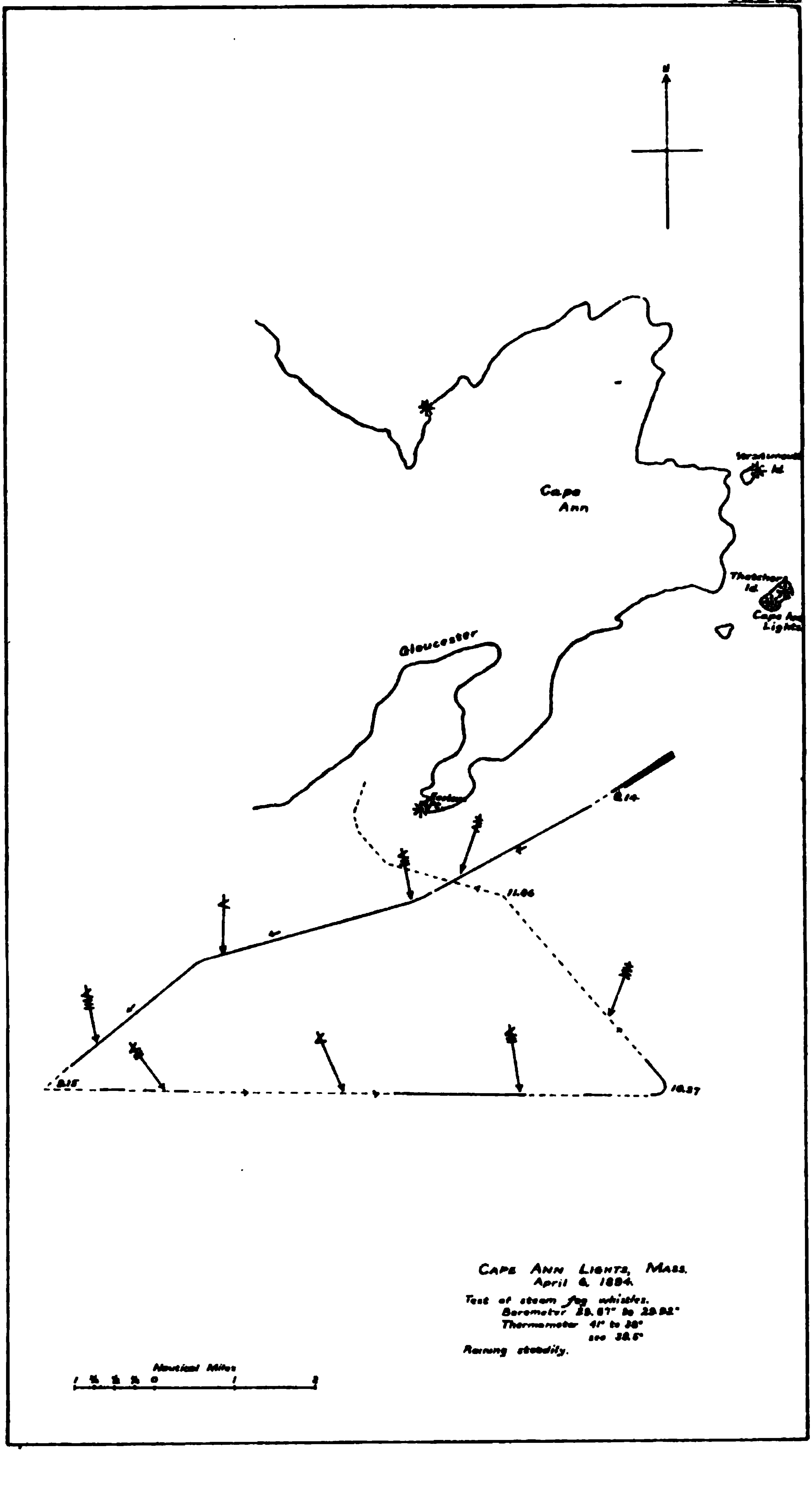

Portland Head Lt.
Cape Elizabeth Lights.
Whistling Buoy
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Portland Head, Me.
Sept. 4, 1893.
Test of 2d Class Daboll Trumpet.
Barometer 29.9"
Cloudiness 0.
Sea Calm.

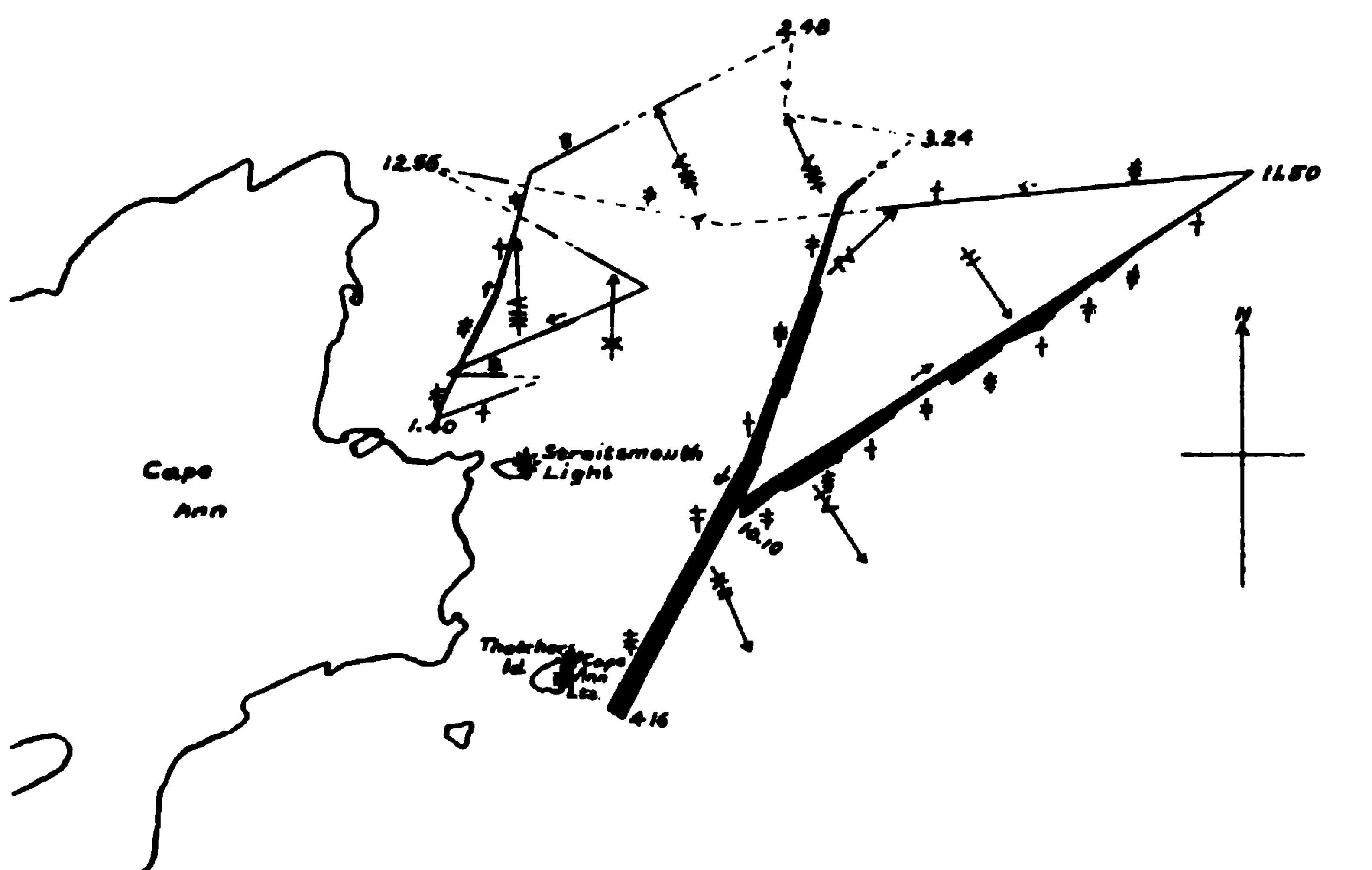

Nautical Miles
1 ¾ ½ ¼ 0 1 2
Portland Head, Me
Sept. 4, 1893.
Test of Bell (A) 960 lbs
Conditions — see above.


N
Cape
Ann
St. Light
Island
Cape Ann
Lights
Cape Ann Lights, Mass.
Nov 14, 1893.
Test of 10" steam whistle.
Barometer 30.05" to 30.10"
Thermometer 57° to 58°.
Sea smooth, long swell.
Sky clear, with cumulus
clouds in west.
Nautical Miles
1 ¾ ½ ¼ 0 1 2


N
Bar Id.
Bar
Harbor
Round
Porcupine
Id.
Egg Rock
Light
Bar Harbor, Me.
Nov 18, 1893.
Test of Bell B-1040 lbs.
Barometer 29.8"
Thermometer 47.5°
Sea rough, wave heights 1.5 ft.
Sky lowering, changing to
dark clouds.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

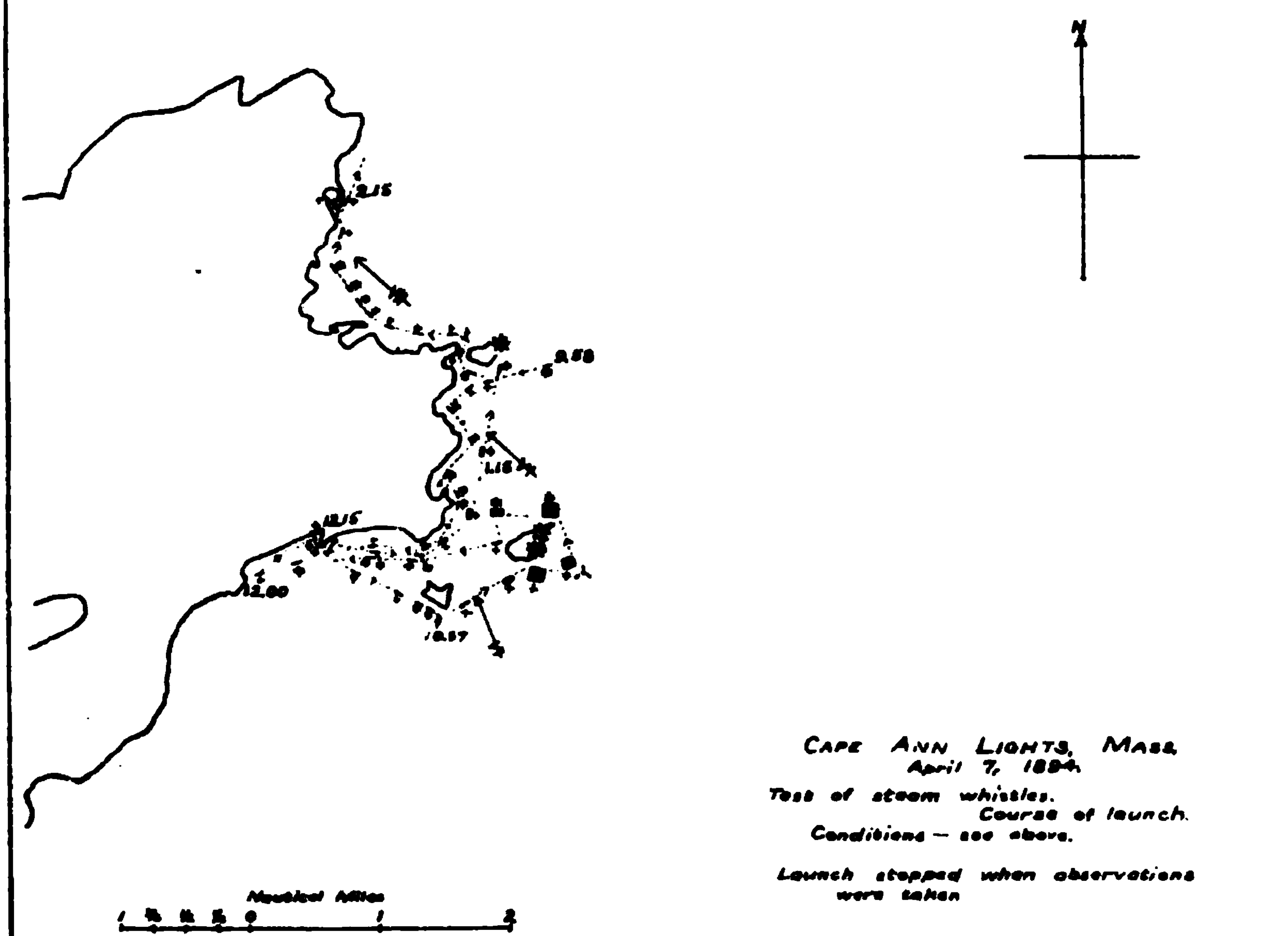

N
Straitsmouth Id.
Cape Ann
Thatchers Id.
Cape Ann Lights
12.07
12.30
4.50
Nautical Miles
0
1
2
Cape Ann Lights, Mass.
April 5, 1894.
Test of steam fog whistles.
Cloudy and threatening rain
North whistle blowing
South whistle blowing.
Both whistles blowing.


Cape Ann
Gloucester
Thatchers Id.
8.15
11.06
10.27
Cape Ann Lights, Mass.
April 6, 1894.
Test of steam fog whistles.
Barometer 29.67" to 29.92"
Thermometer 41° to 38°
sea 38.5°
Raining steadily.
Nautical Miles



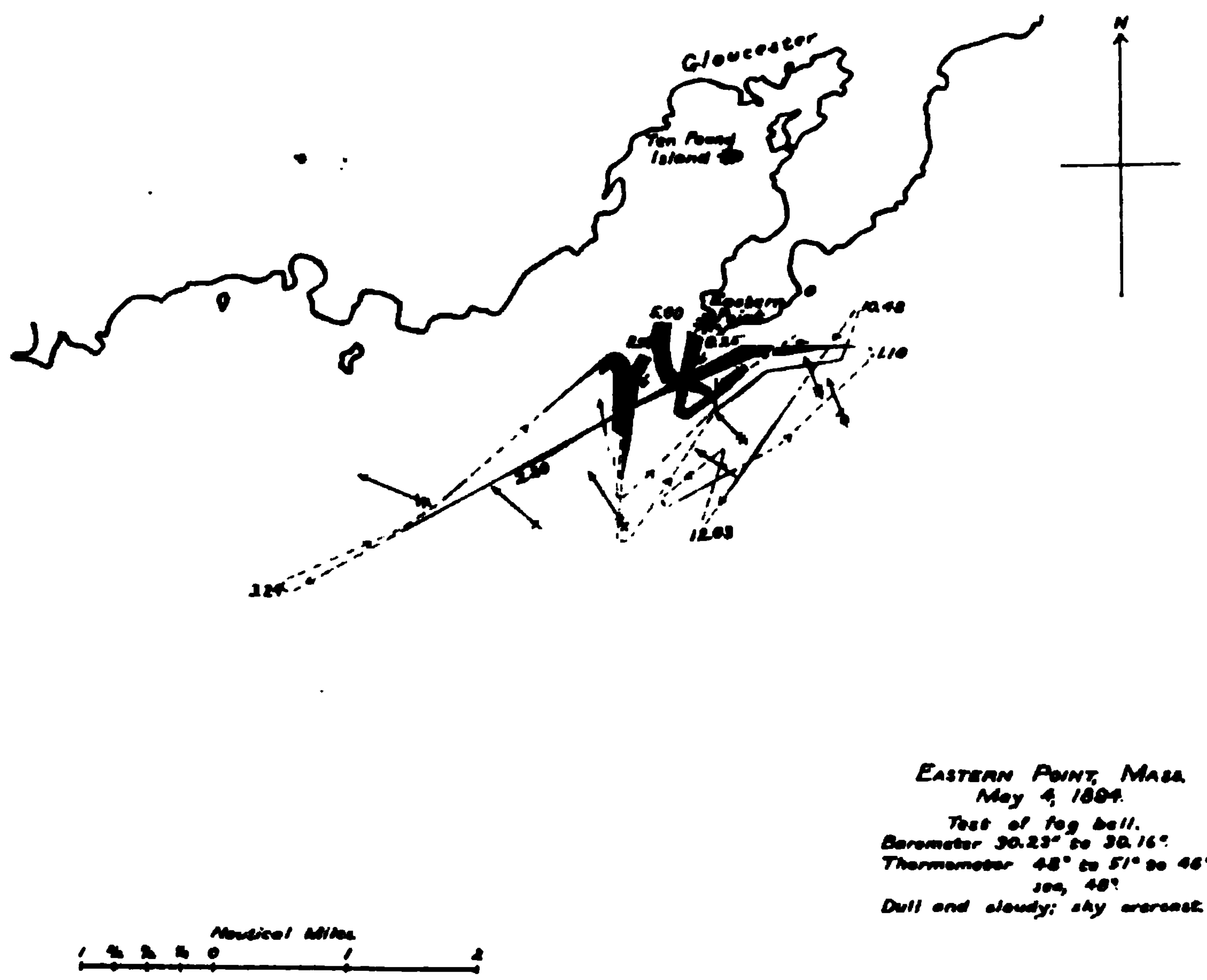
Cape Ann Lights, Mass.
April 7, 1894.
Test of steam whistles.
Barometer 30.10" to 30.15" to 30.10"
Thermometer 37° to 44° to 40°
sea 38° to 39°
Sky clear; sea smooth.

+ North whistle blowing.
+ South whistle blowing.
+ Both whistles blowing.

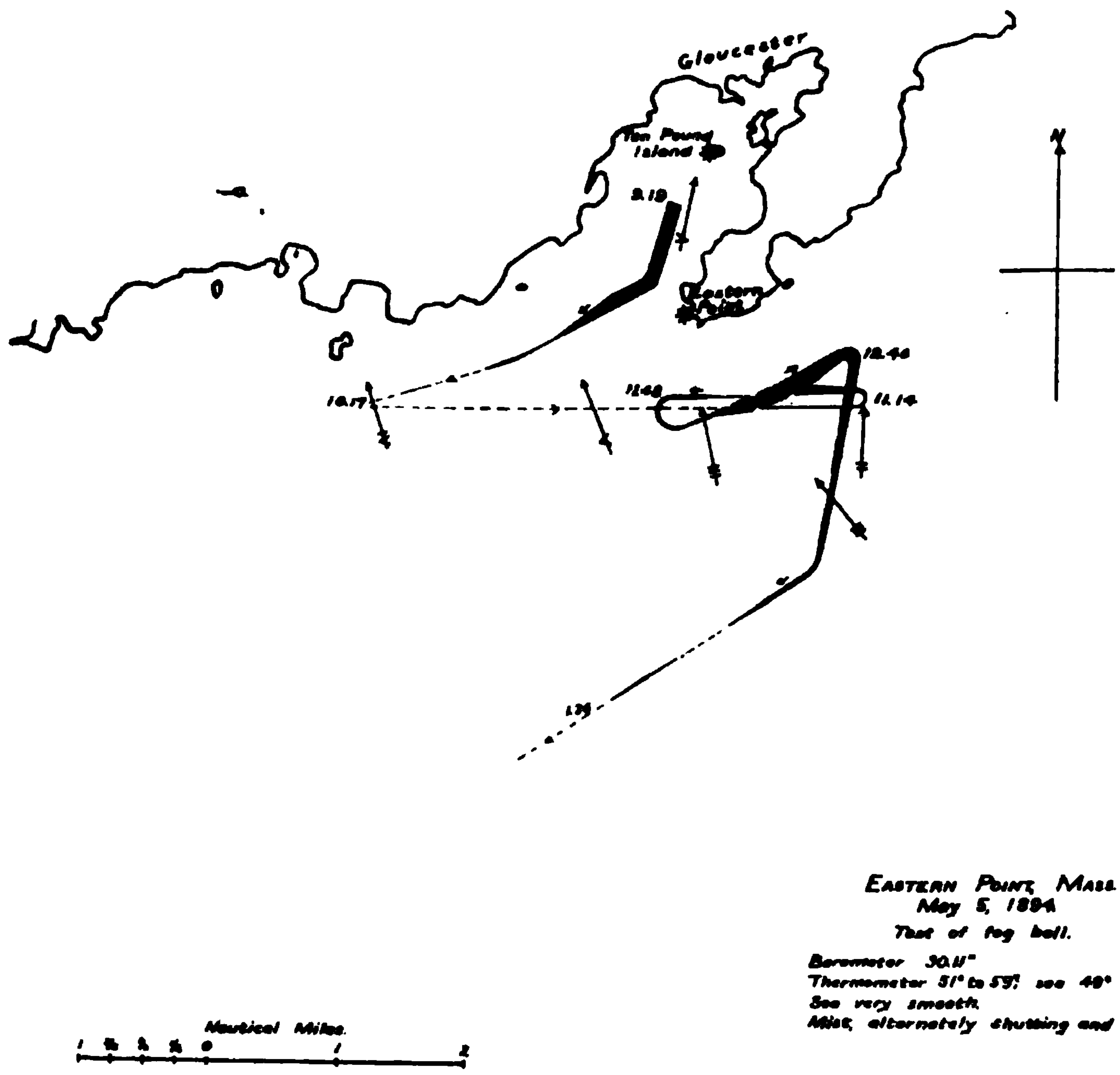


Cape Ann Lights, Mass.
April 7, 1894.
Test of steam whistles.
Course of launch.
Conditions — see above.

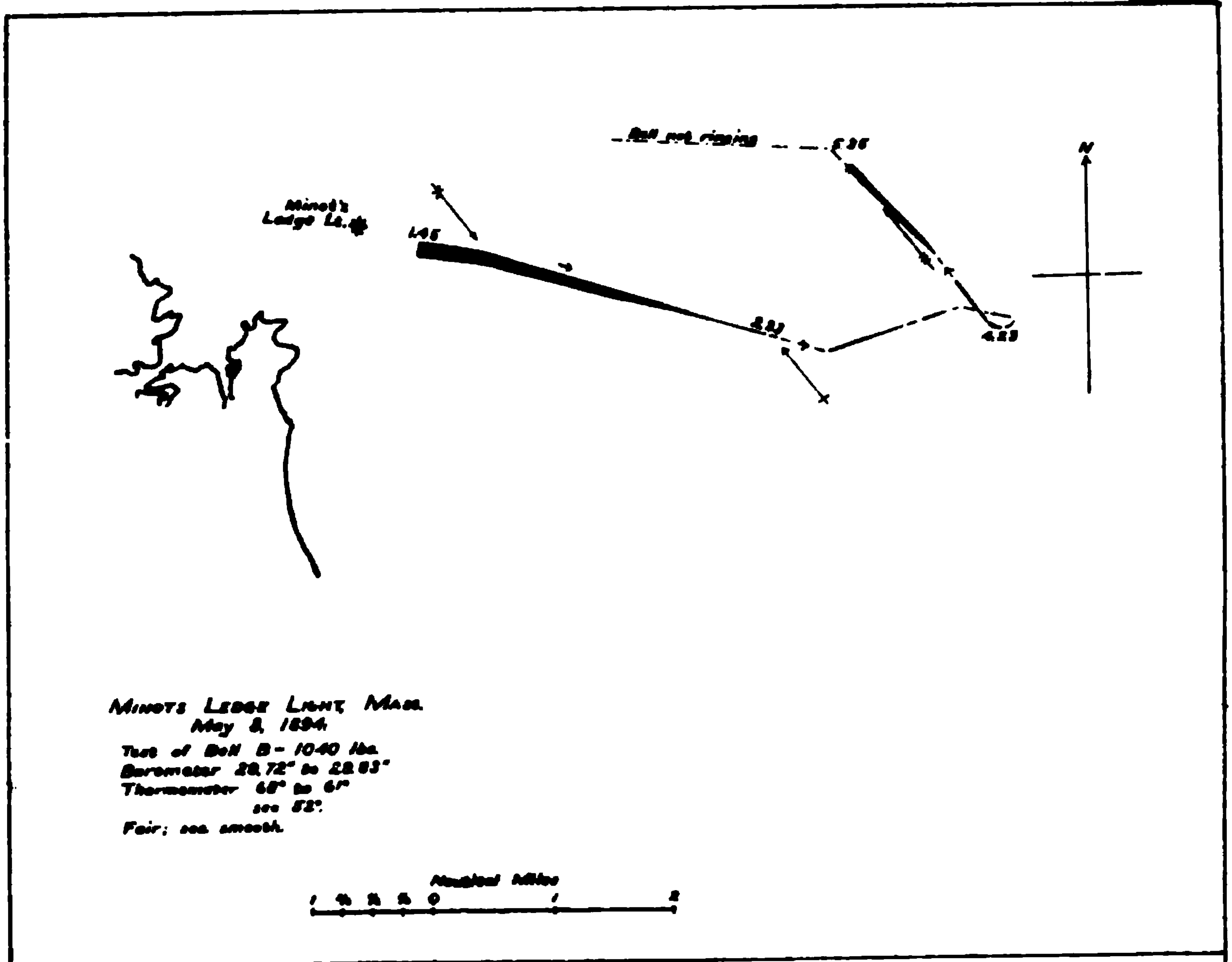
Launch stopped when observations were taken

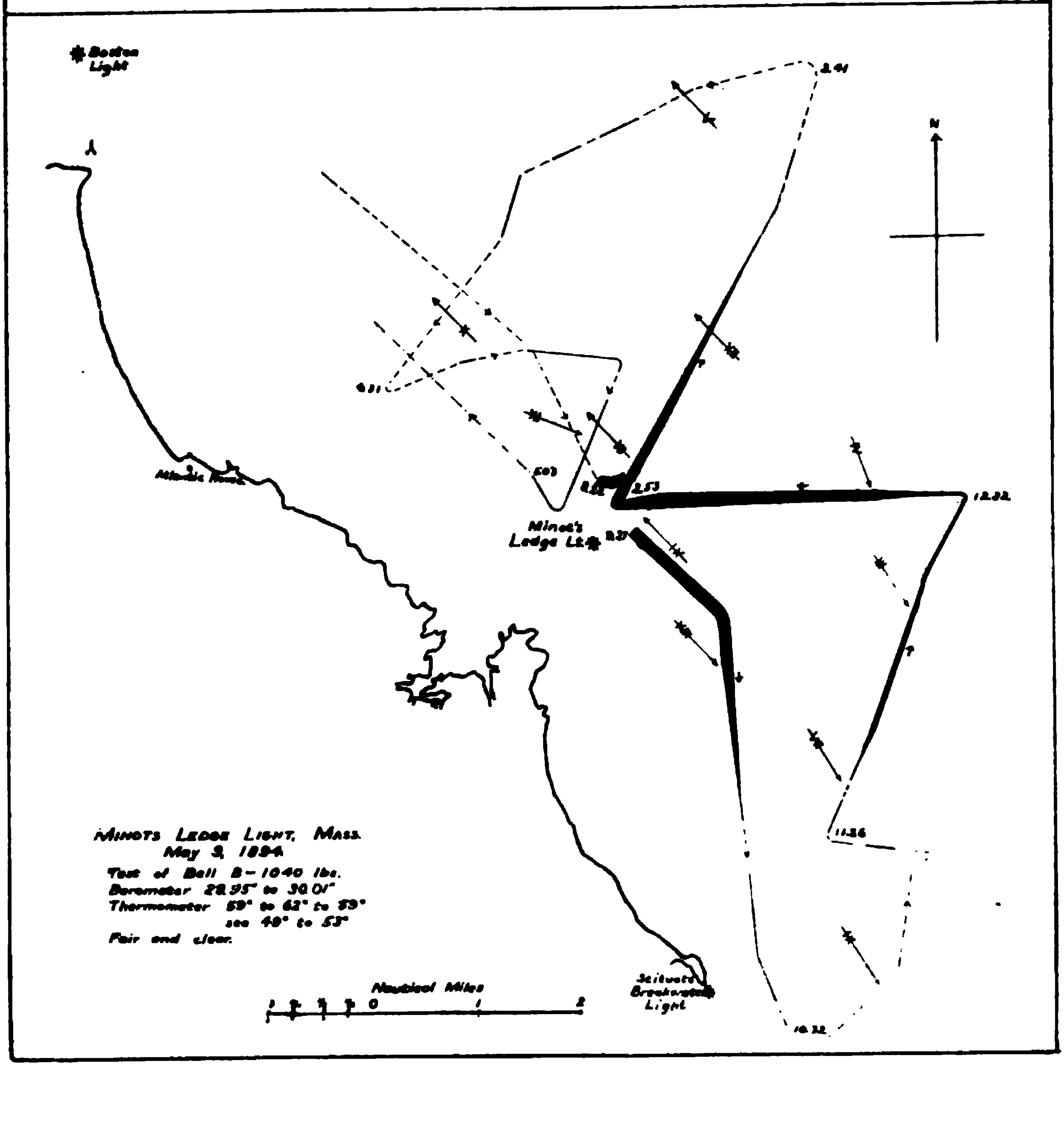


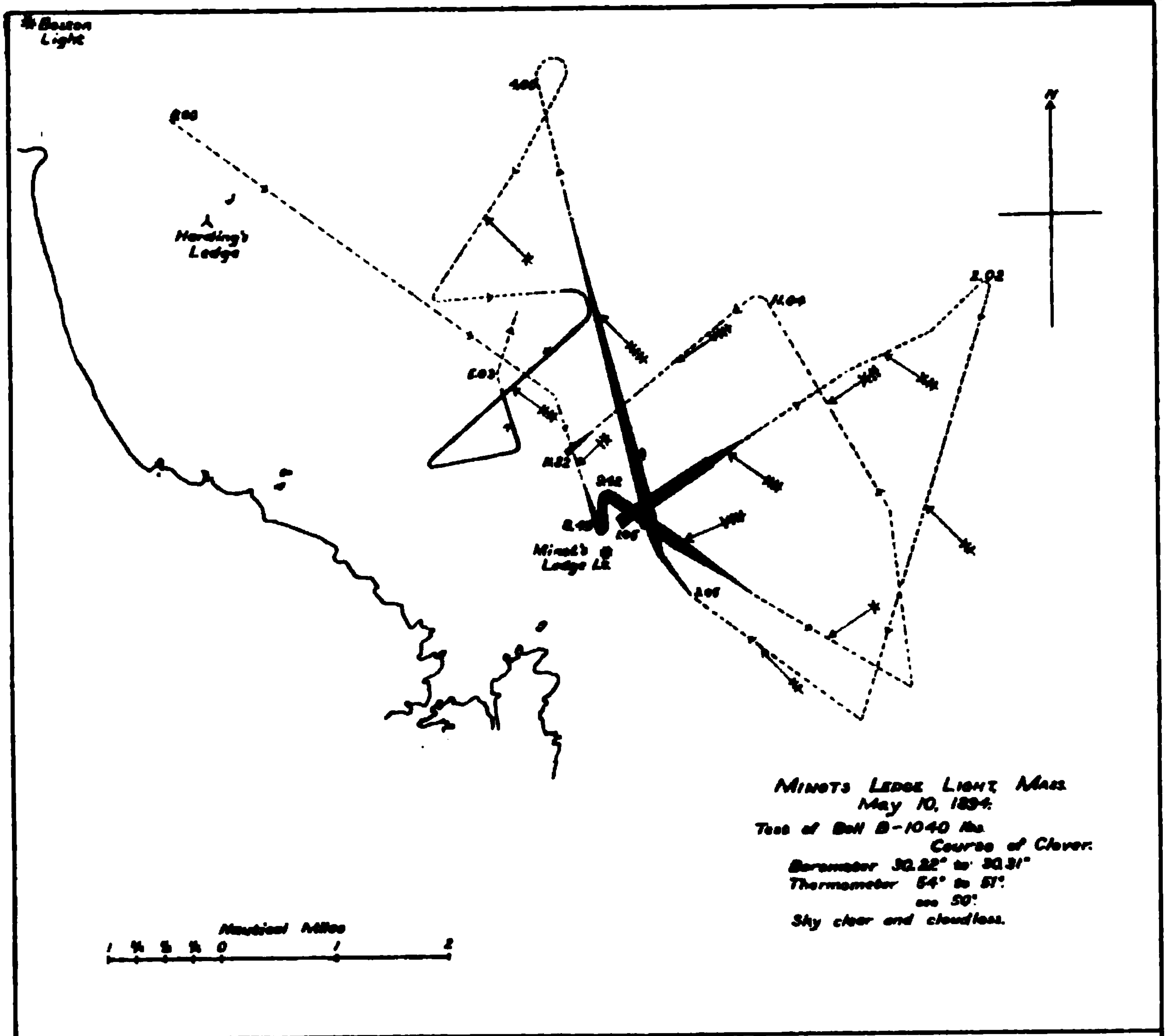
EASTERN POINT, MASS.
May 4, 1894.
Test of fog bell.
Barometer 30.23" to 30.16".
Thermometer 48° to 51° to 46°
sea, 48°.
Dull and cloudy; sky overcast.

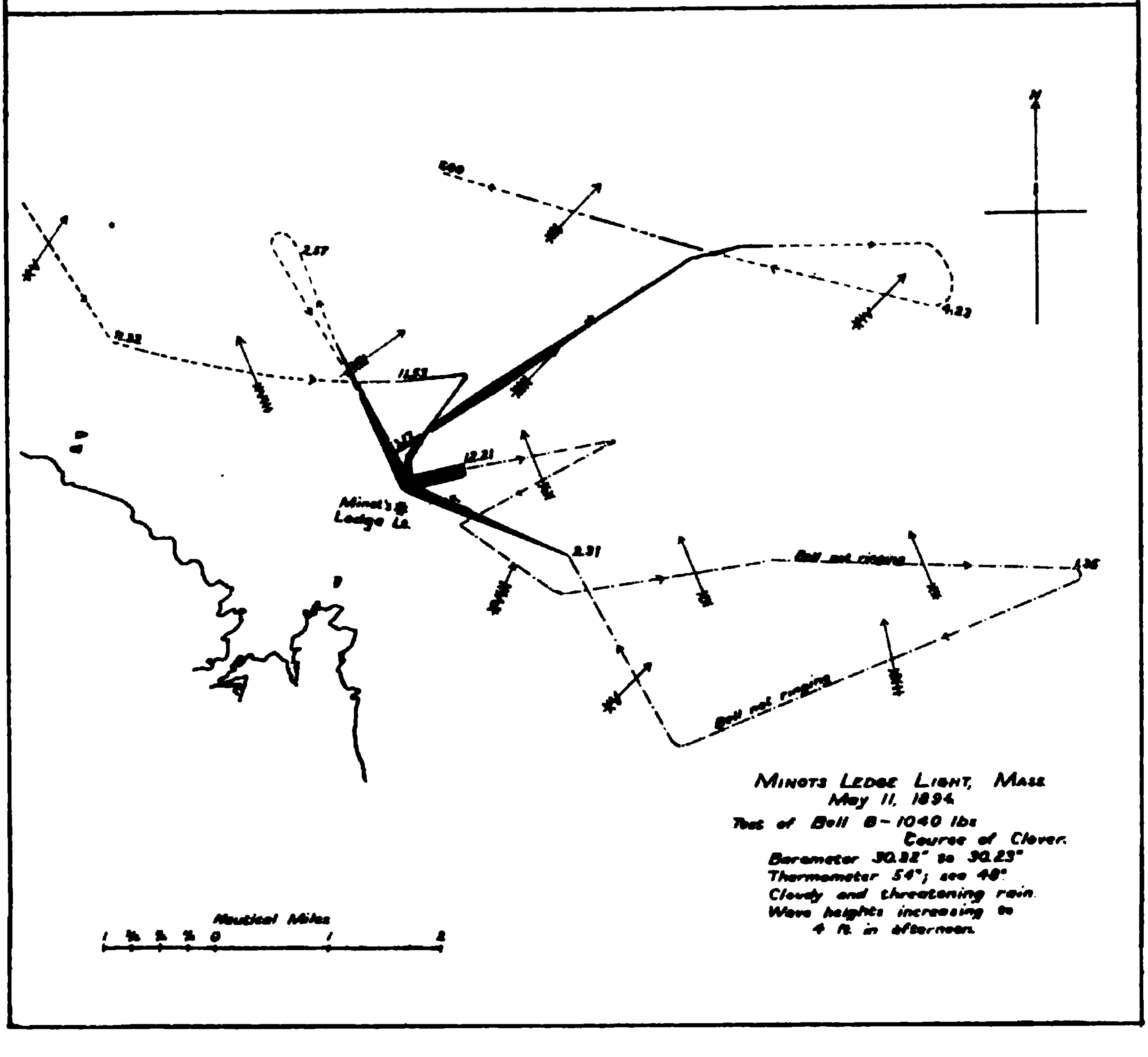


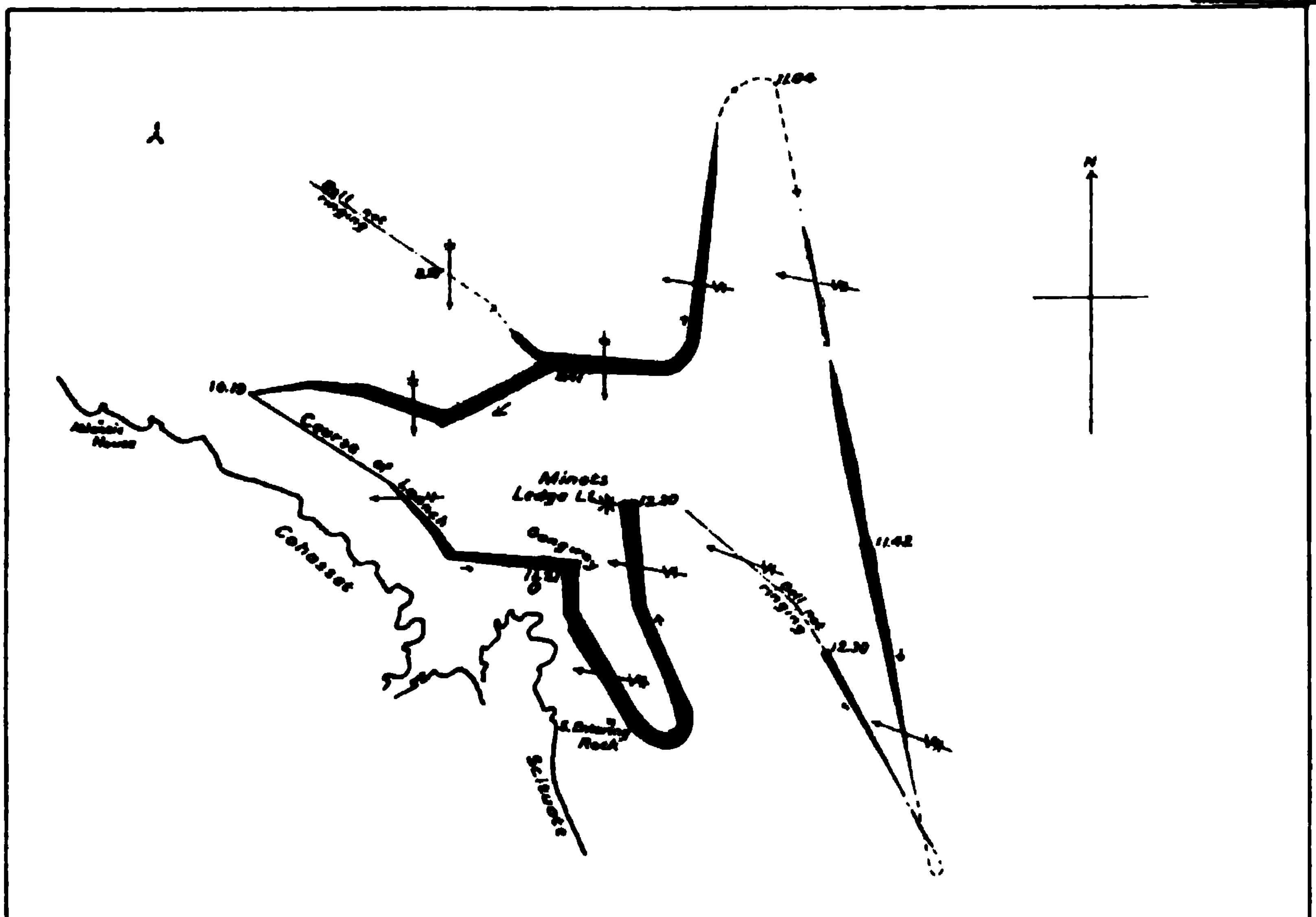
EASTERN POINT, MASS.
May 5, 1894.
Test of fog bell.
Barometer 30.11"
Thermometer 51° to 55°, sea 49°
Sea very smooth.
Mist, alternately shutting and lifting.


Bell not ringing
5.26
N
Minot's Ledge Lt.
1.45
2.53
4.23
Minots Ledge Light, Mass.
May 8, 1894.
Test of Bell B - 1040 lbs.
Barometer 29.72" to 29.83"
Thermometer 68° to 61°
sea 52°.
Fair; sea smooth.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

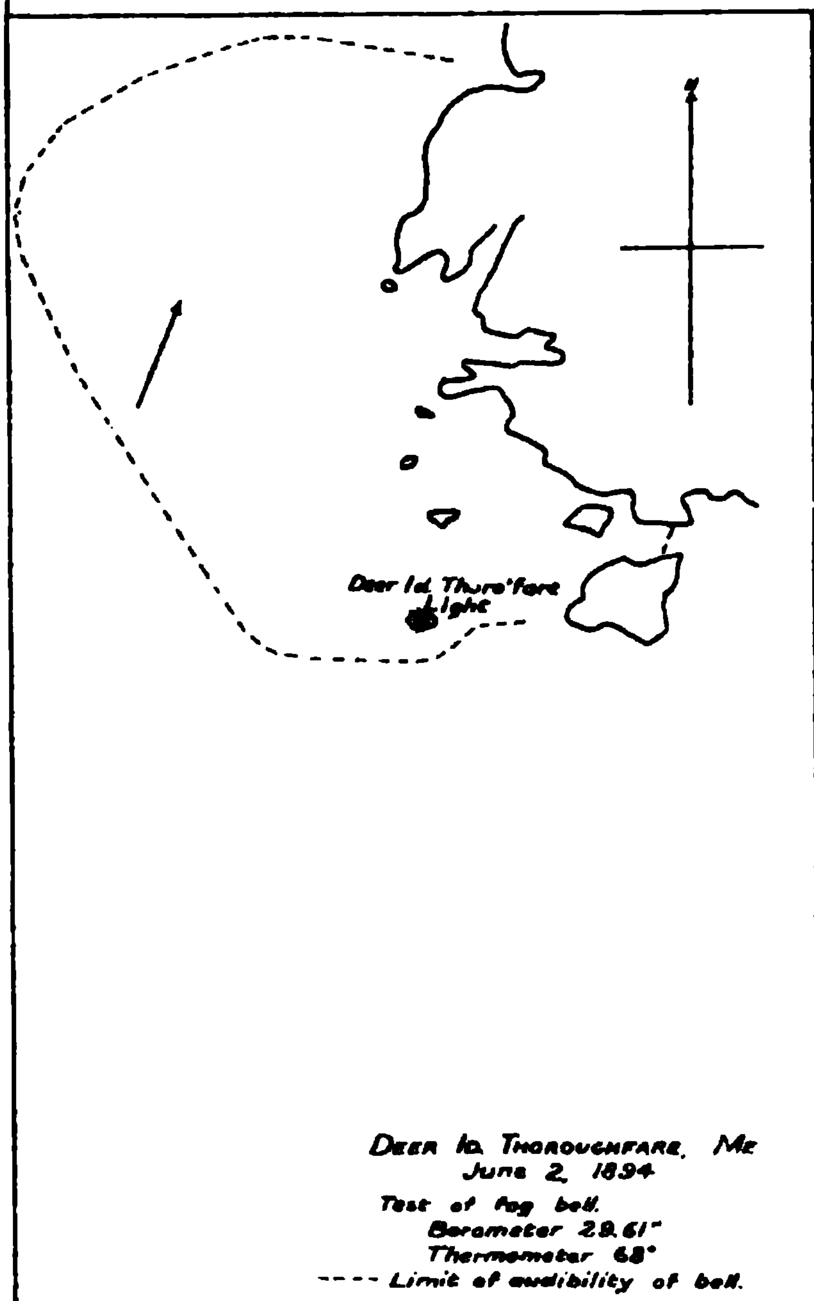

Boston Light
2.41
N
4.31
5.03
2.53
12.32
Minot's Ledge Lt.
11.26
10.32
Scituate Breakwater Light
Minots Ledge Light, Mass.
May 9, 1894.
Test of Bell B - 1040 lbs.
Barometer 29.95" to 30.01"
Thermometer 59° to 62° to 59°
sea 49° to 53°
Fair and clear.
Nautical Miles
1 ¾ ½ ¼ 0 1 2


Boston Light
Harding's Ledge
Minot's Ledge Lt.
Minots Ledge Light, Mass.
May 10, 1894.
Test of Bell B-1040 lbs.
Course of Clover.
Barometer 30.22" to 30.31"
Thermometer 54° to 51°.
sea 50°.
Sky clear and cloudless.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

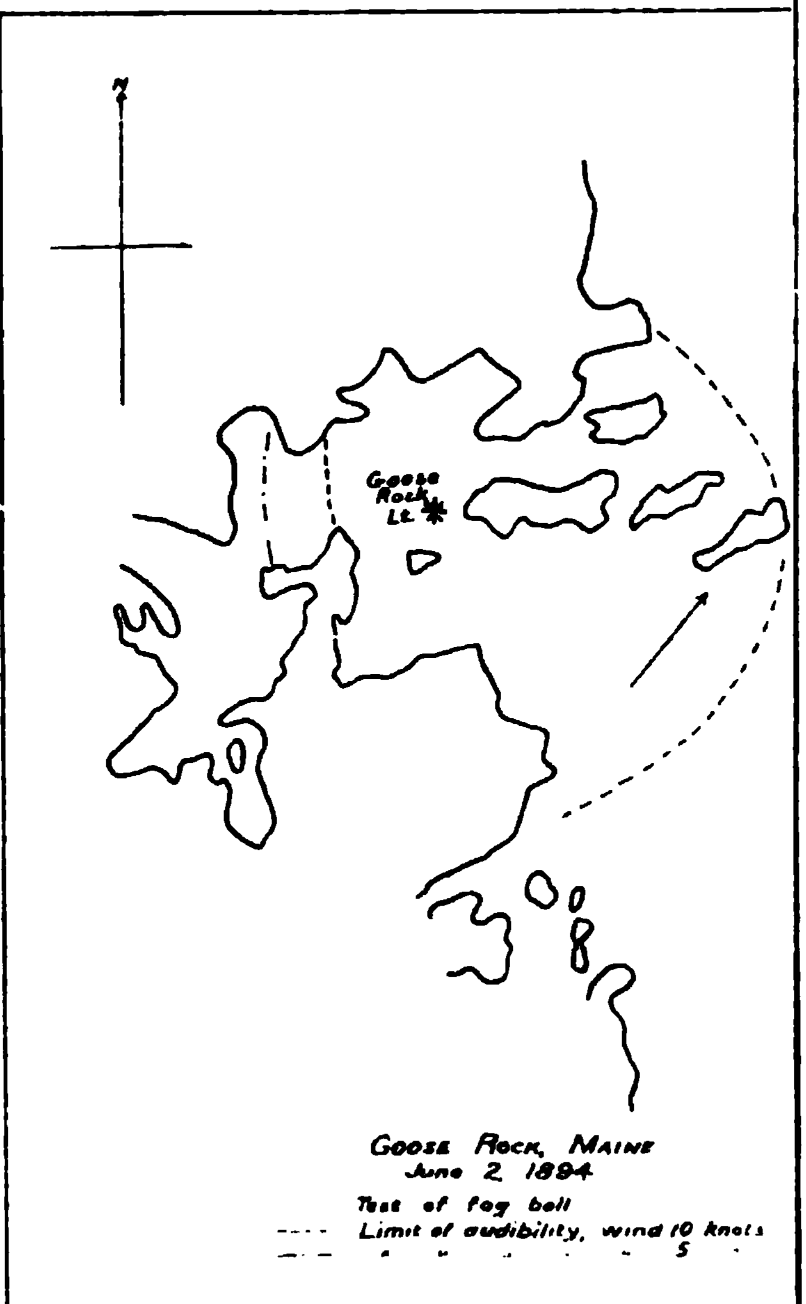

Minot's Ledge Lt.
Bell not ringing
Bell not ringing
Minots Ledge Light, Mass
May 11, 1894
Test of Bell B-1040 lbs
Course of Clover.
Barometer 30.22" to 30.23"
Thermometer 54°; sea 48°
Cloudy and threatening rain.
Wave heights increasing to
4 ft. in afternoon.
Nautical Miles
1 ¾ ½ ¼ 0 1 2



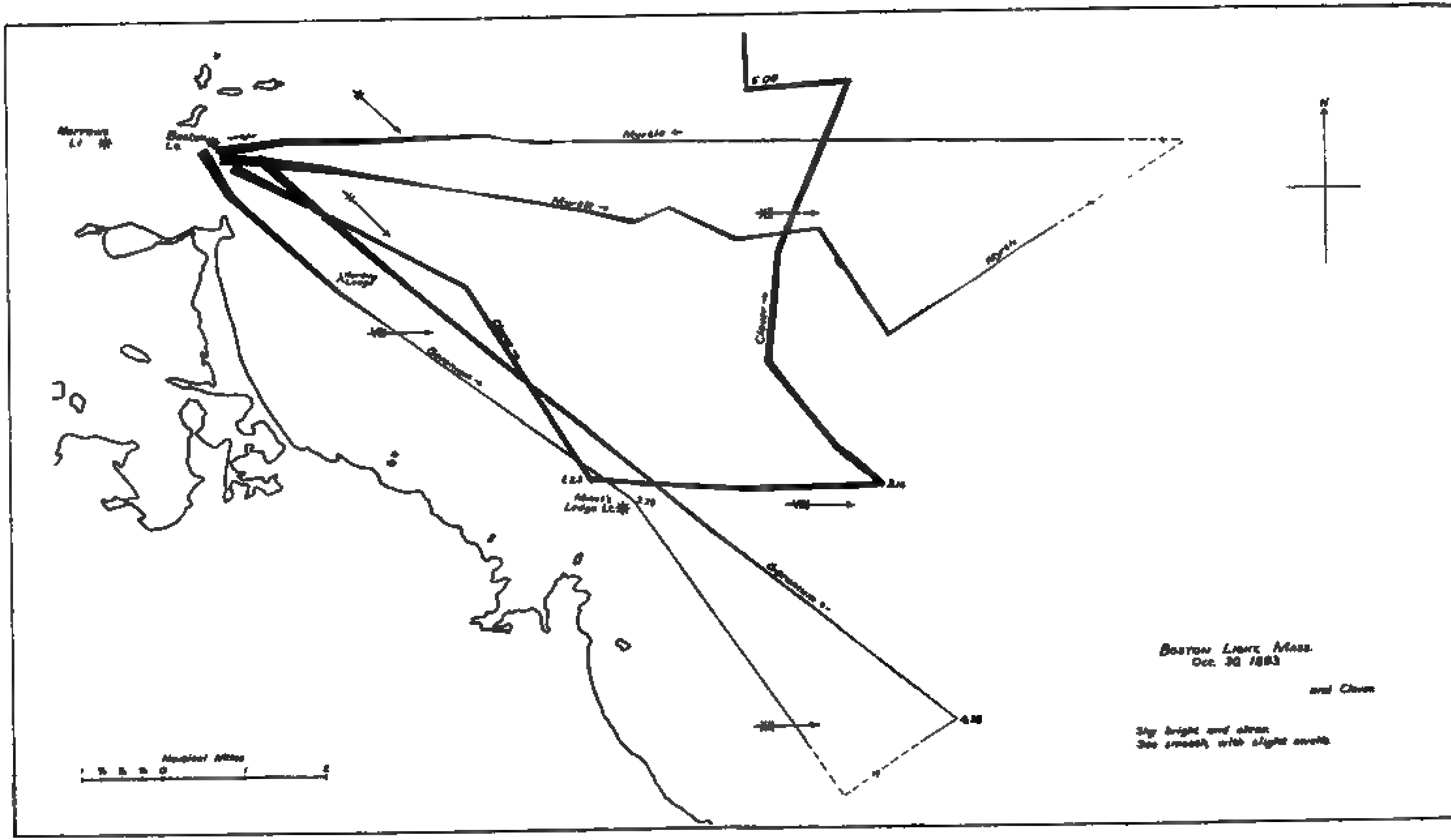
Minots Ledge Light, Mass
May 12, 1894
Test of Bell B-1040 lbs.
Barometer 30.32"
Thermometer 60° to 57°
sea 60°
Sky clear

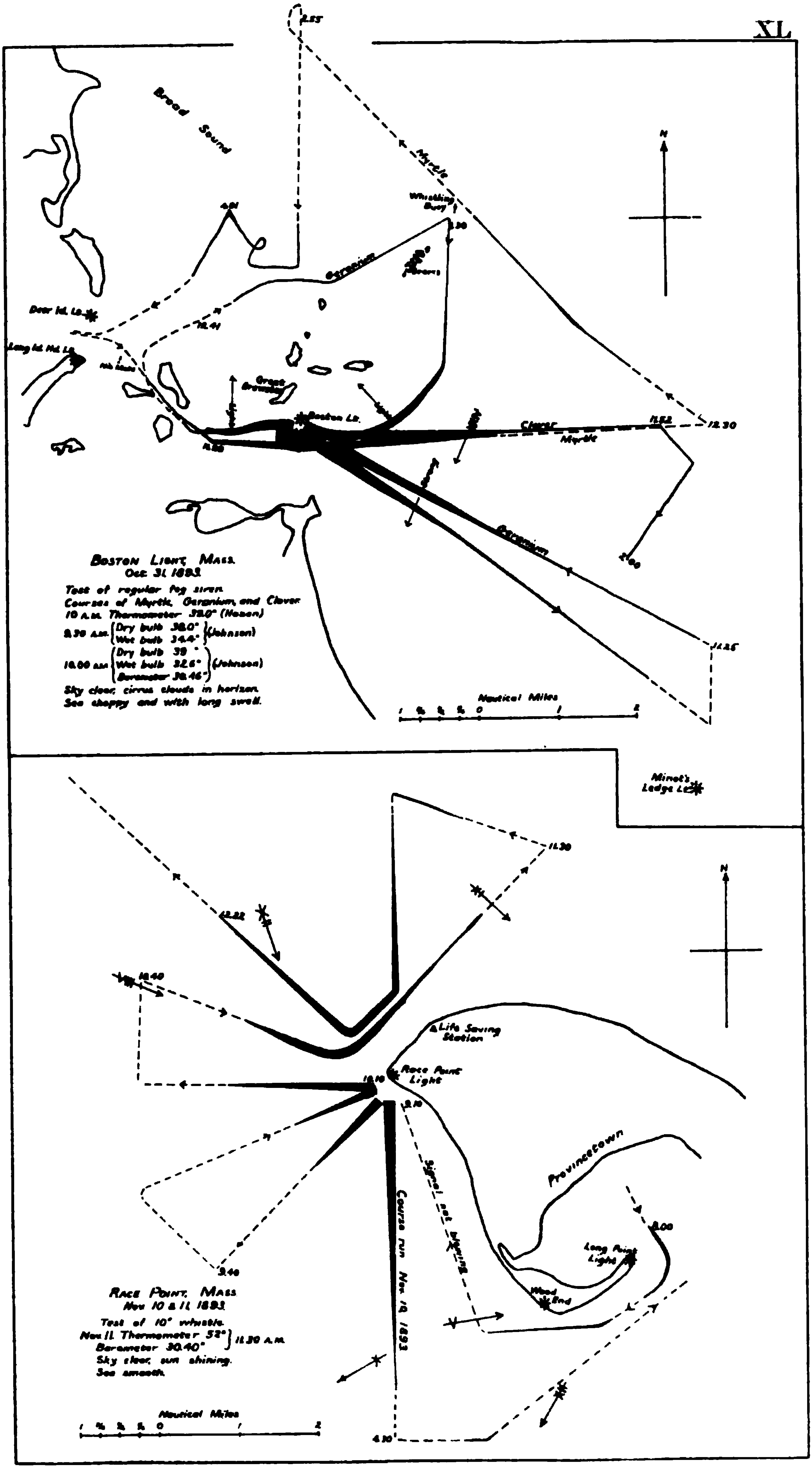


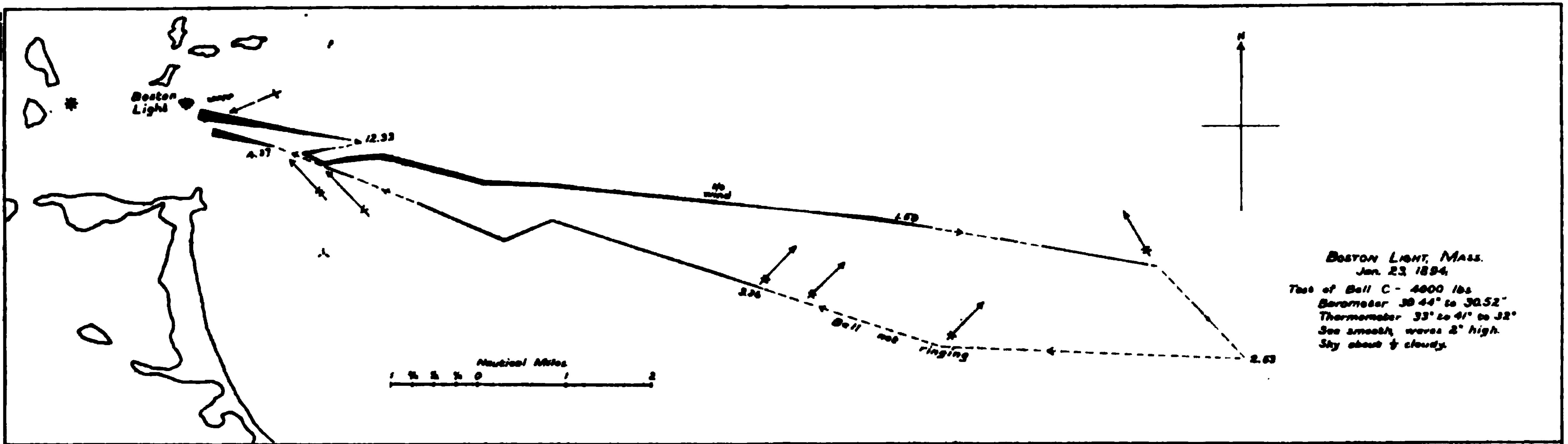
Deer Id. Thoroughfare, Me.
June 2, 1894
Test of fog bell.
Barometer 29.61"
Thermometer 68°
---- Limit of audibility of bell.



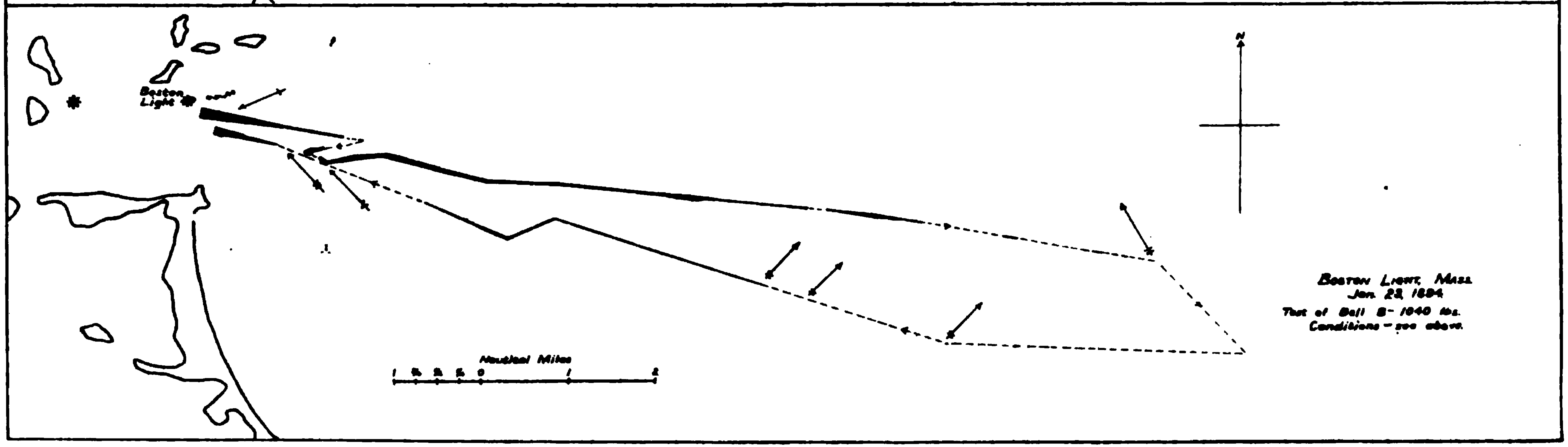
Goose Rock, Maine
June 2, 1894
Test of fog bell
Limit of audibility, wind 10 knots
" " " " 5 "


Boston Light, Mass.
Oct. 30 1883
Sky bright and clear.
Sea smooth, with slight swells
Boston Lt.
Nautical Miles
N

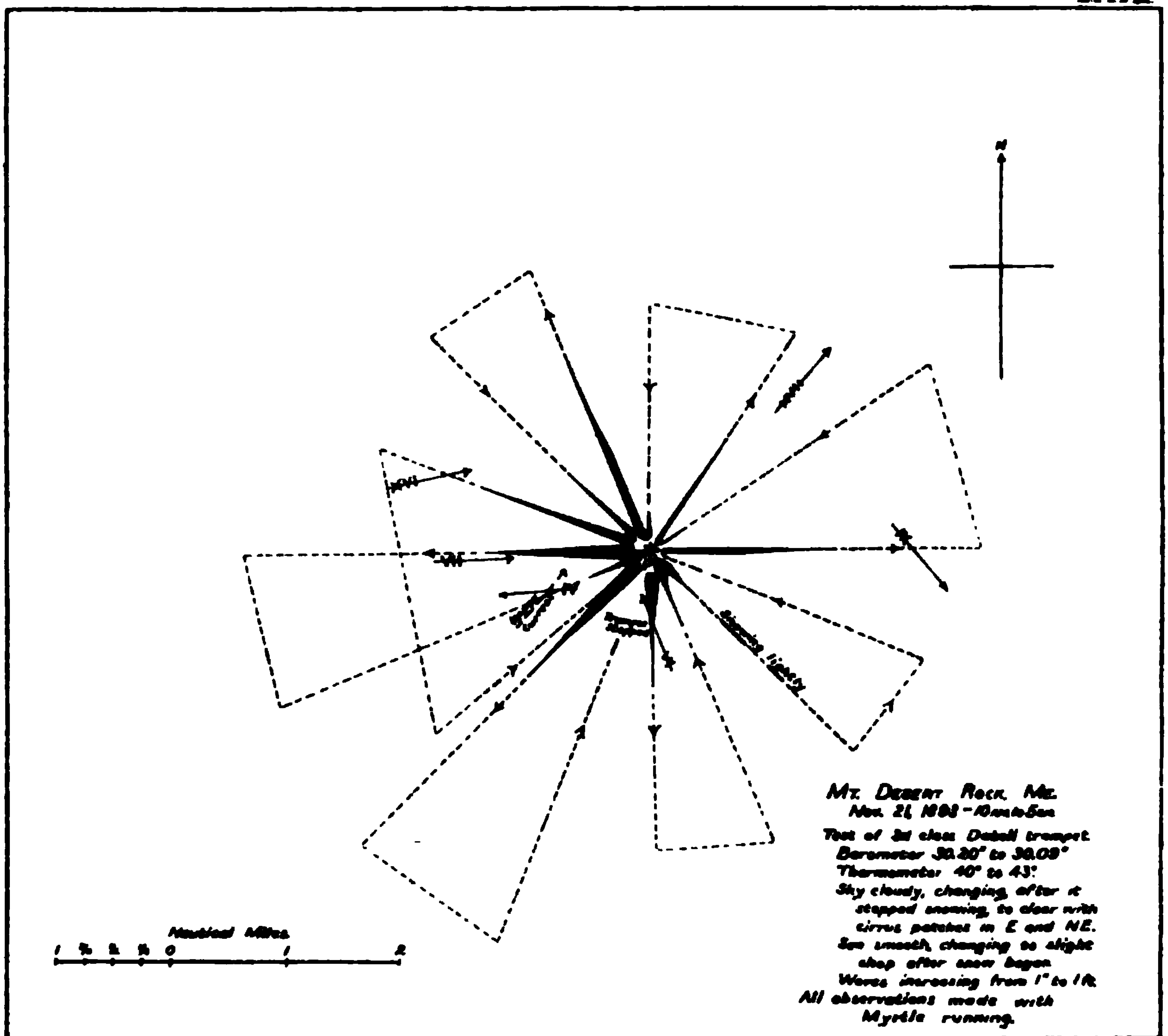

Broad Sound
Myrtle
Whistling Buoy
Geranium
Deer Id. Lt.
Long Id. Hd. Lt.
Boston Lt.
Clover
Myrtle
Geranium
Boston Light, Mass.
Oct. 31, 1893.
Test of regular fog siren.
Courses of Myrtle, Geranium, and Clover.
10 A.M. Thermometer 38.0° (Hazen)
8.30 A.M. Dry bulb 38.0° Wet bulb 34.4° (Johnson)
10.00 A.M. Dry bulb 39° Wet bulb 32.6° Barometer 30.46" (Johnson)
Sky clear, cirrus clouds in horizon.
Sea choppy and with long swell.
Nautical Miles
1 ¾ ½ ¼ 0 1 2
N
Minot's Ledge Lt.
Life Saving Station
Race Point Light
Provincetown
Signal not heard
Course run Nov. 10, 1893
Long Point Light
Wood End
Race Point, Mass.
Nov. 10 & 11, 1893.
Test of 10" whistle.
Nov. 11. Thermometer 52° Barometer 30.40" 11.30 A.M.
Sky clear, sun shining.
Sea smooth.
Nautical Miles
1 ¾ ½ ¼ 0 1 2
N

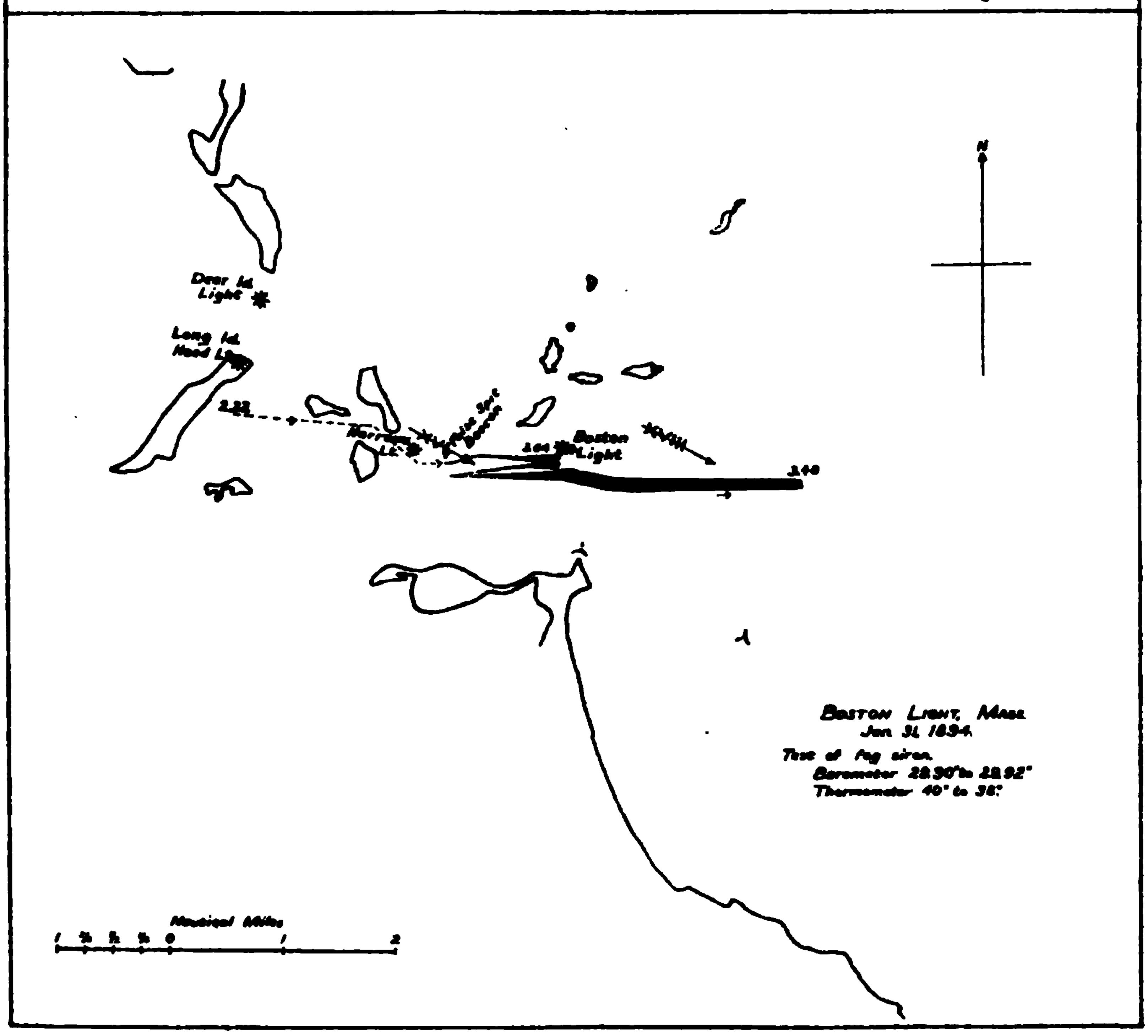


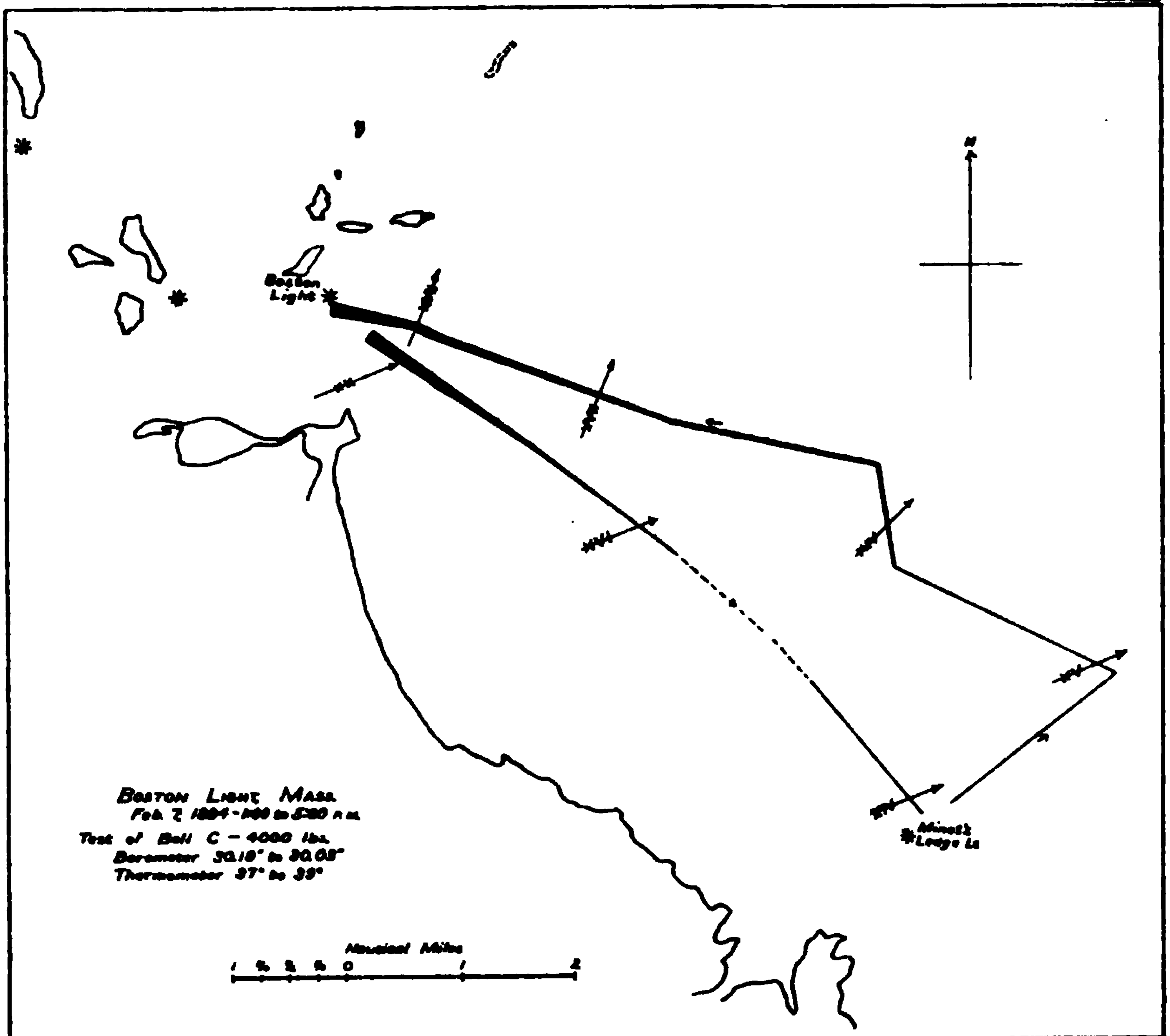
Boston Light, Mass.
Jan. 23, 1894.
Test of Bell C – 4000 lbs.
Barometer 30.44" to 30.52"
Thermometer 33° to 41° to 32°
Sea smooth, waves 2" high.
Sky about ½ cloudy.

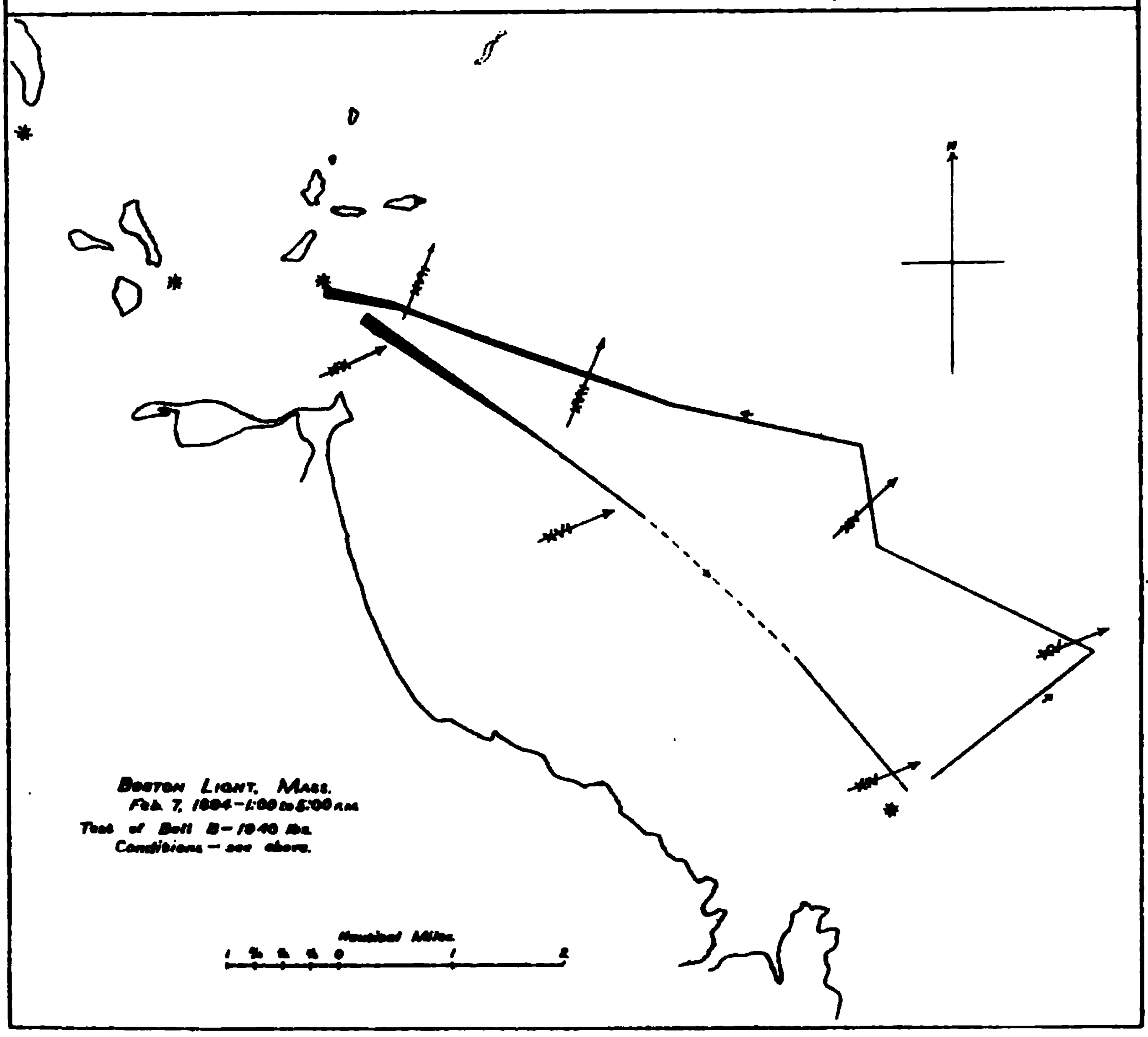


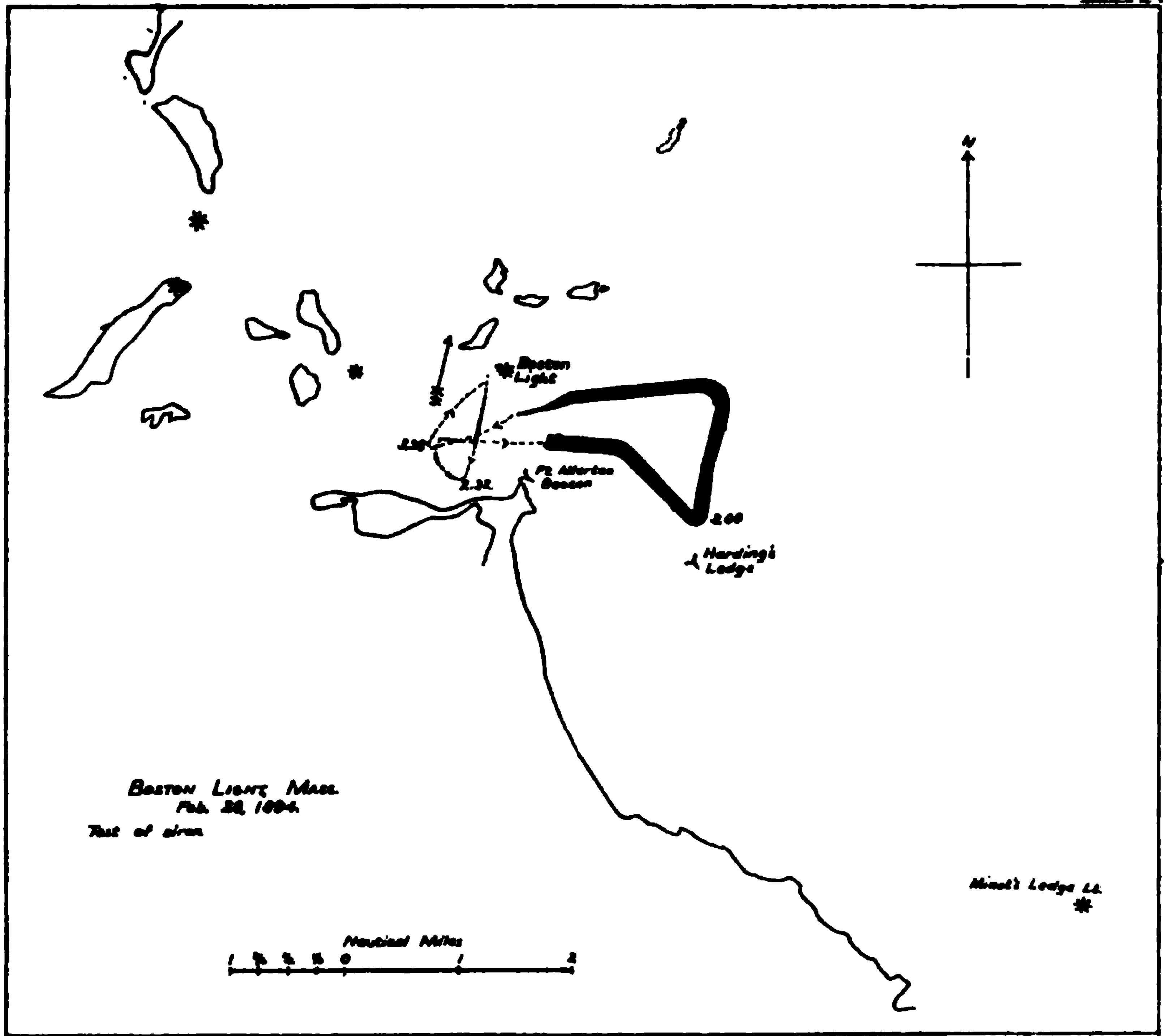
Boston Light, Mass.
Jan. 23, 1894.
Test of Bell B – 1840 lbs.
Conditions – see above.

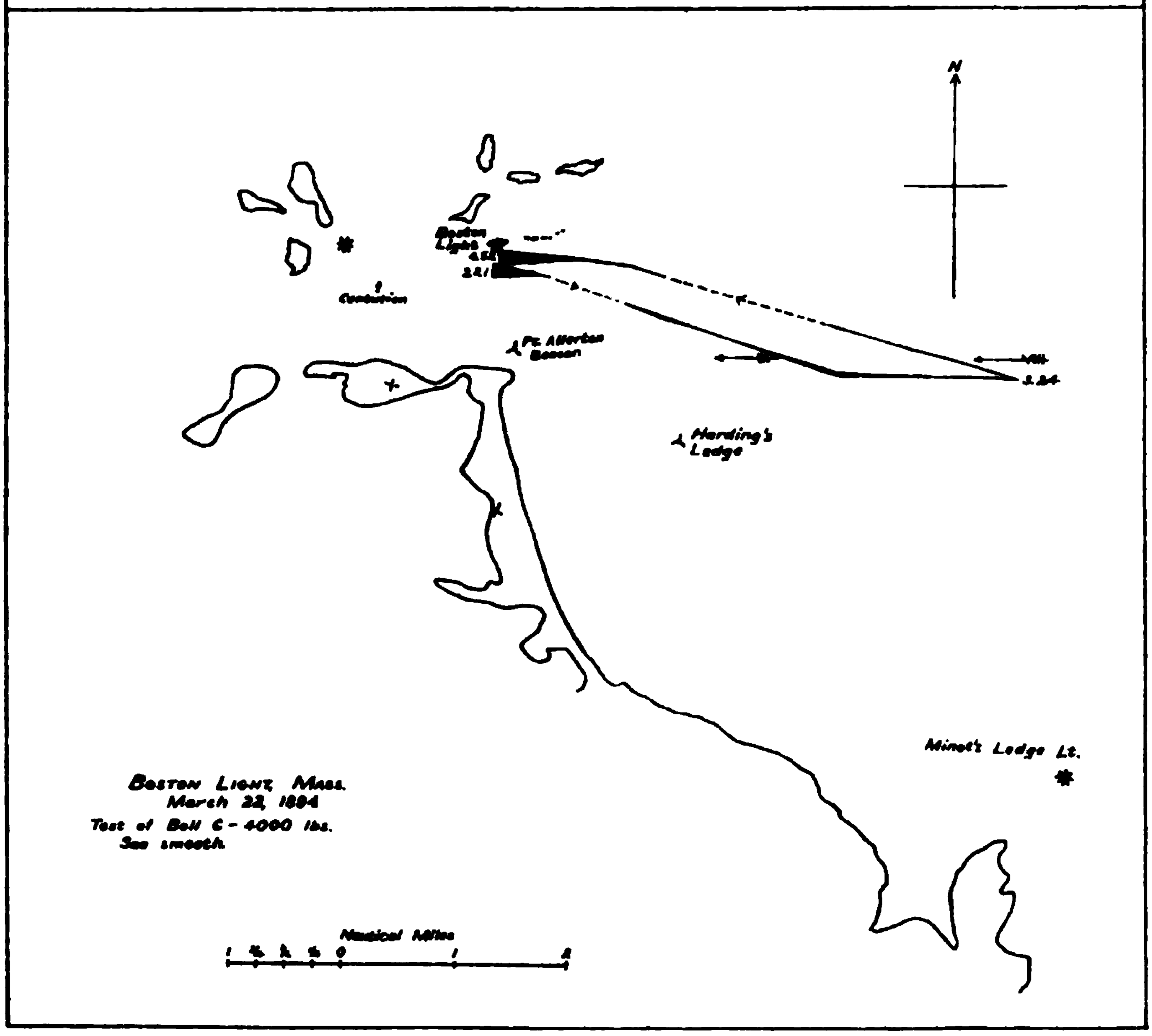

N
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Mt. Desert Rock, Me.
Nov. 21, 1893 – 10am to 5pm
Test of 3d class Daboll trumpet.
Barometer 30.20" to 30.09"
Thermometer 40° to 43°.
Sky cloudy, changing, after it stopped snowing, to clear with cirrus patches in E and NE.
Sea smooth, changing to slight chop after snow began.
Waves increasing from 1" to 1 ft.
All observations made with Myrtle running.

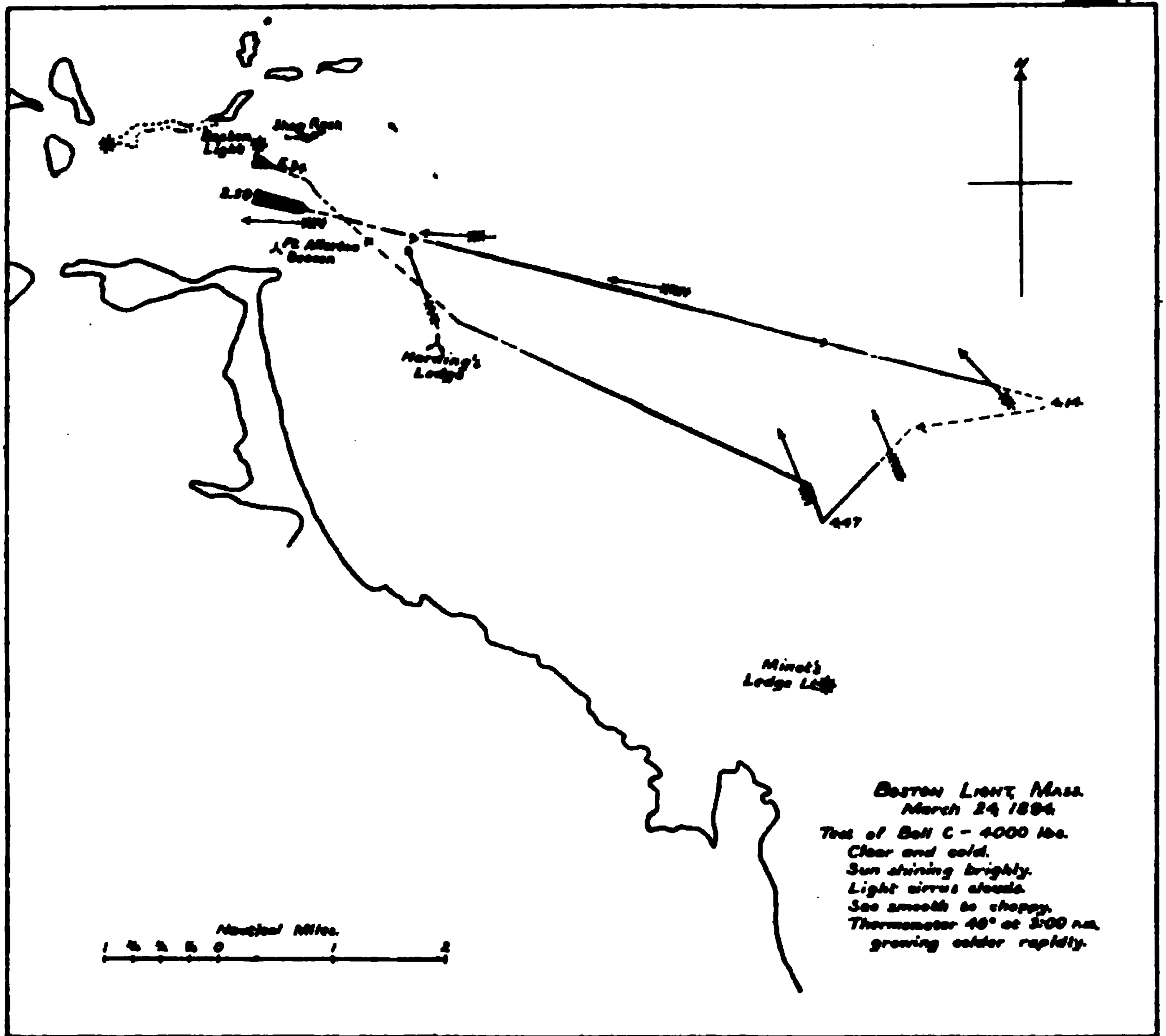

N
Deer Id. Light
Long Id. Head Lt.
Boston Light
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Boston Light, Mass.
Jan. 31, 1894.
Test of fog siren.
Barometer 29.90" to 29.92"
Thermometer 40° to 38°.

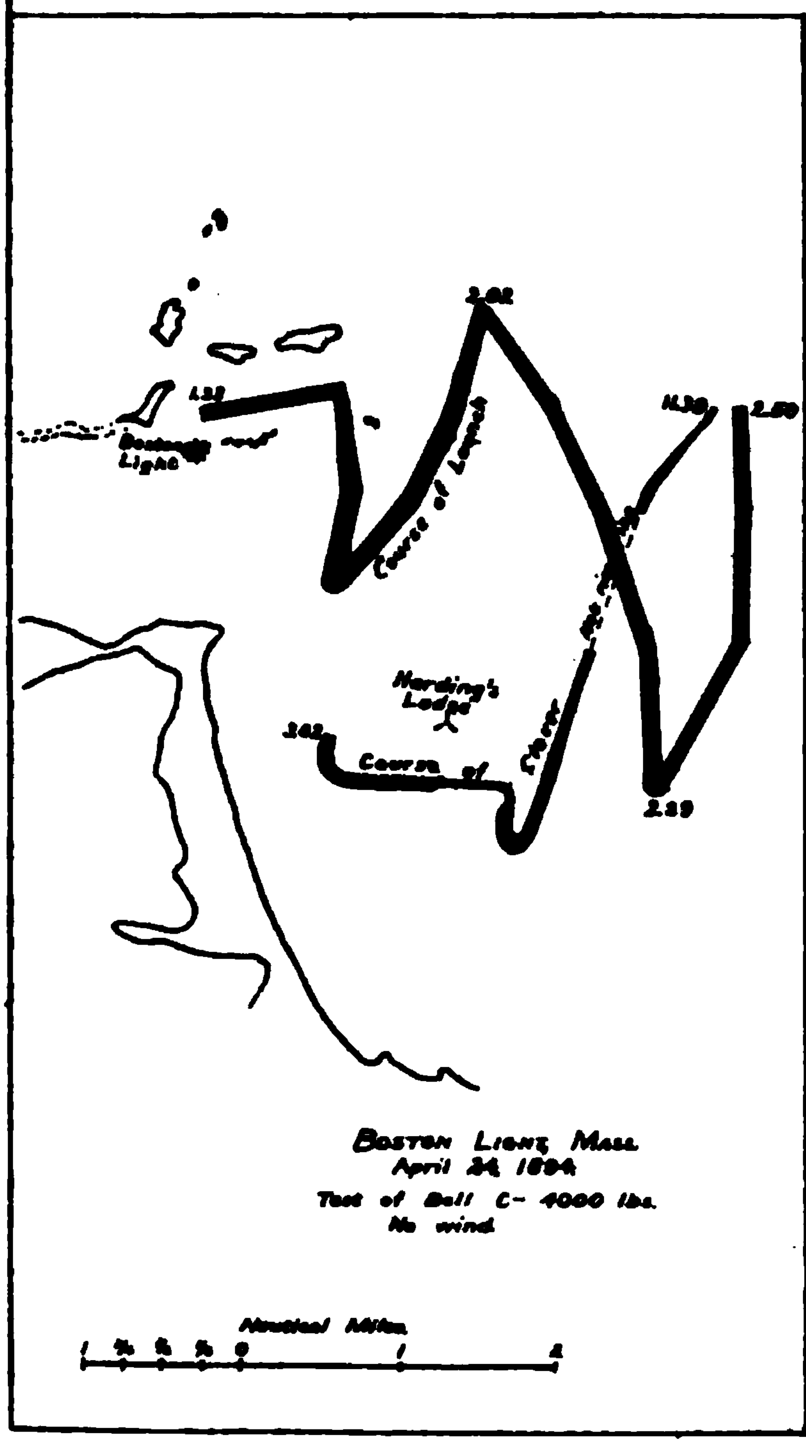

N
Boston Light
Minot's Ledge Lt.
Boston Light, Mass.
Feb. 7, 1894 - 1:00 to 5:00 A.M.
Test of Bell C - 4000 lbs.
Barometer 30.18" to 30.05"
Thermometer 37° to 39°
Nautical Miles
1 ¾ ½ ¼ 0 1 2

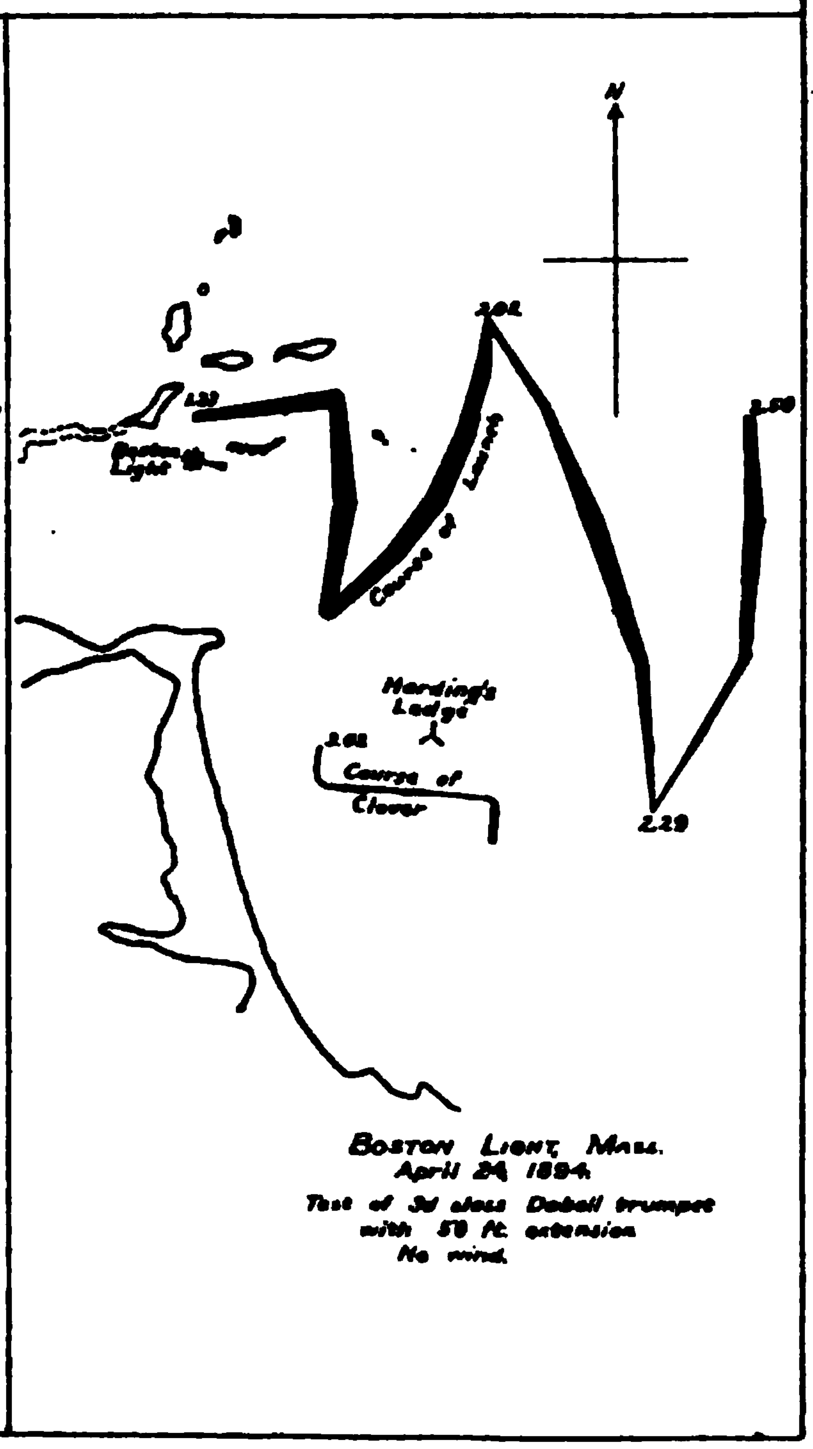

N
Boston Light, Mass.
Feb. 7, 1894 - 1:00 to 5:00 A.M.
Test of Bell B - 1940 lbs.
Conditions - see above.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

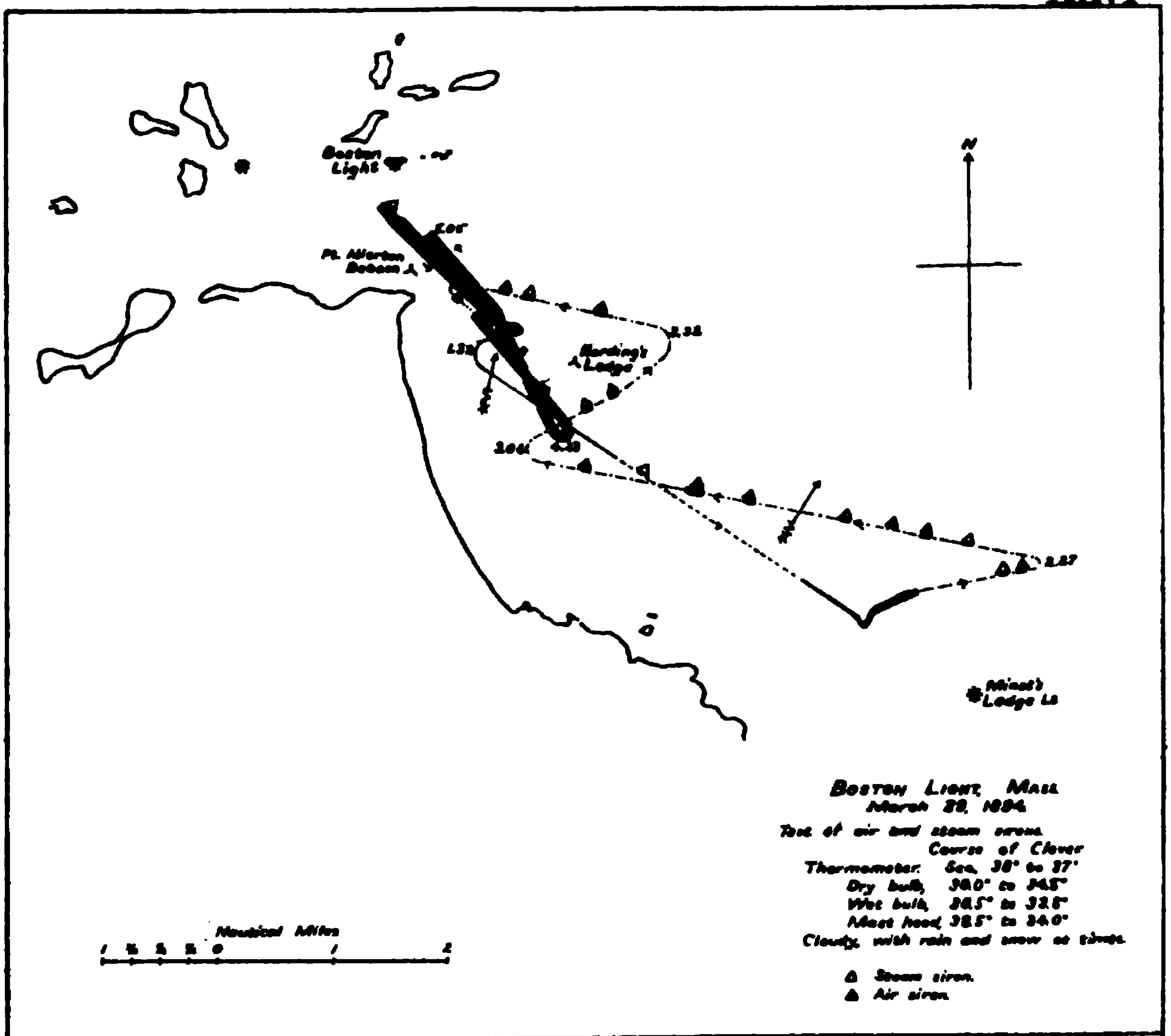

N
Boston Light
2.32
Pt. Allerton Beacon
Harding's Ledge
Boston Light, Mass.
Test of siren.
Minot's Ledge Lt.
Nautical Miles


N
Boston Light
2.21
Pt. Allerton Beacon
Harding's Ledge
Minot's Ledge Lt.
Boston Light, Mass.
March 22, 1894
Test of Bell C - 4000 lbs.
Sea smooth.
Nautical Miles

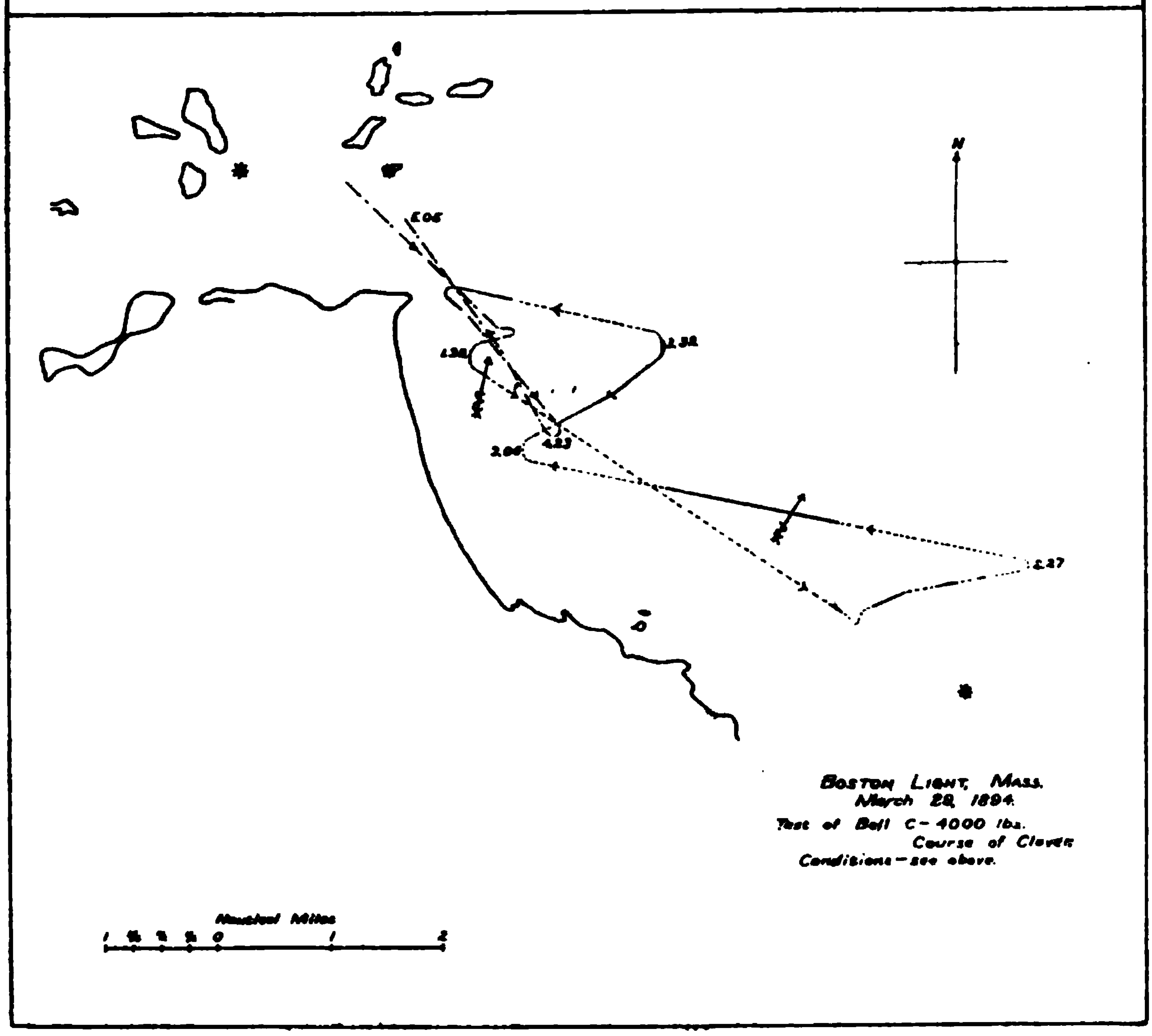

N
Boston Light
Harding's Ledge
Minot's Ledge Lt.
4.14
4.47
Boston Light, Mass.
March 24 1894
Test of Bell C - 4000 lbs.
Clear and cold.
Sun shining brightly.
Light cirrus clouds.
Sea smooth to choppy.
Thermometer 46° at 3:00 p.m.
growing colder rapidly.
Nautical Miles.
1 ¾ ½ ¼ 0 1 2


2.02
1.32
11.30
2.50
Boston Light
Course of Launch
Harding's Ledge
2.62
Course of Clover
2.29
Boston Light, Mass.
April 24, 1894.
Test of Bell C - 4000 lbs.
No wind.
Nautical Miles.
1 ¾ ½ ¼ 0 1 2

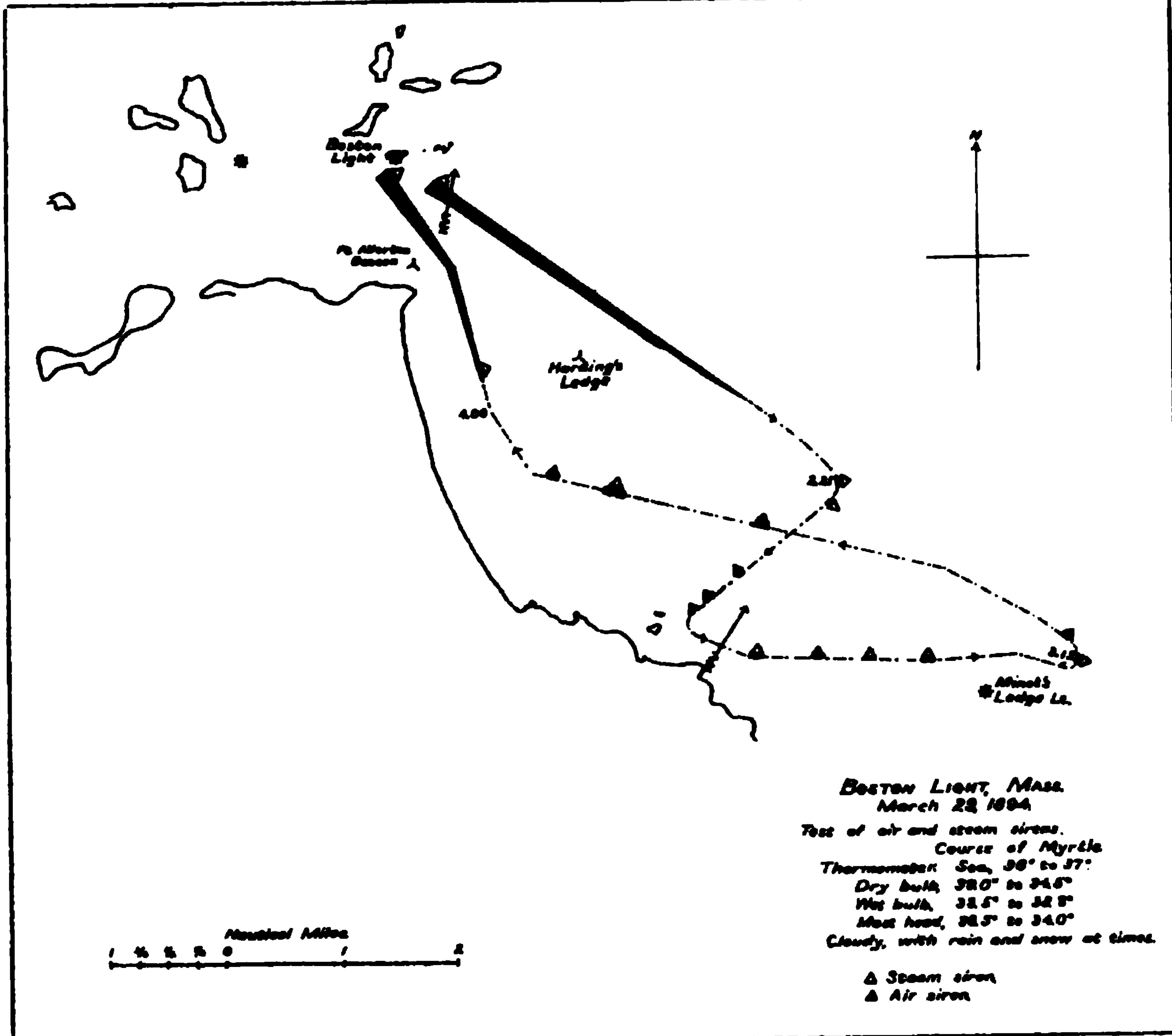

N
2.02
1.32
2.50
Boston Light
Course of Launch
Harding's Ledge
2.62
Course of Clover
2.29
Boston Light, Mass.
April 24, 1894.
Test of 3d class Daboll trumpet
with 59 ft. extension
No wind.

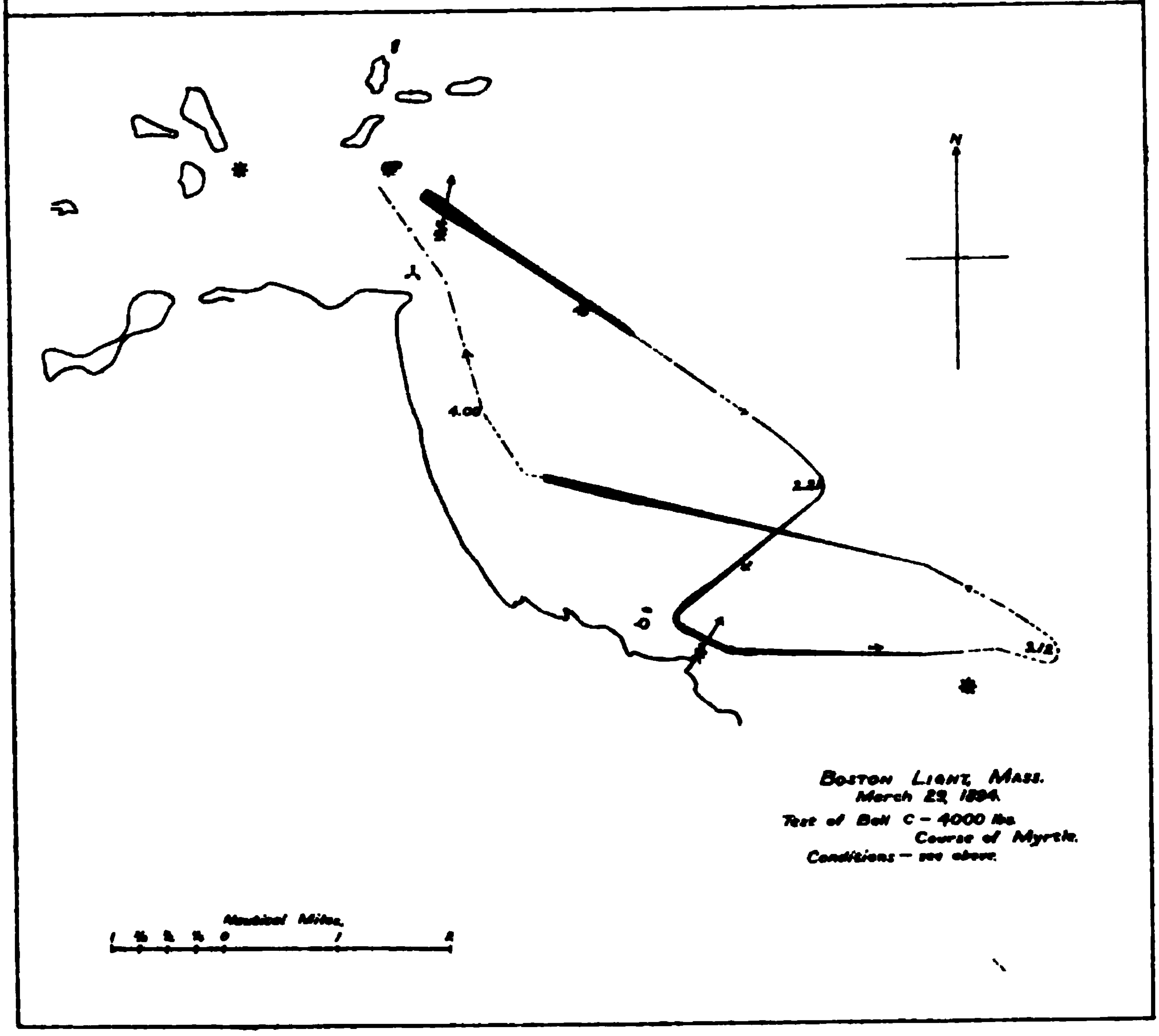


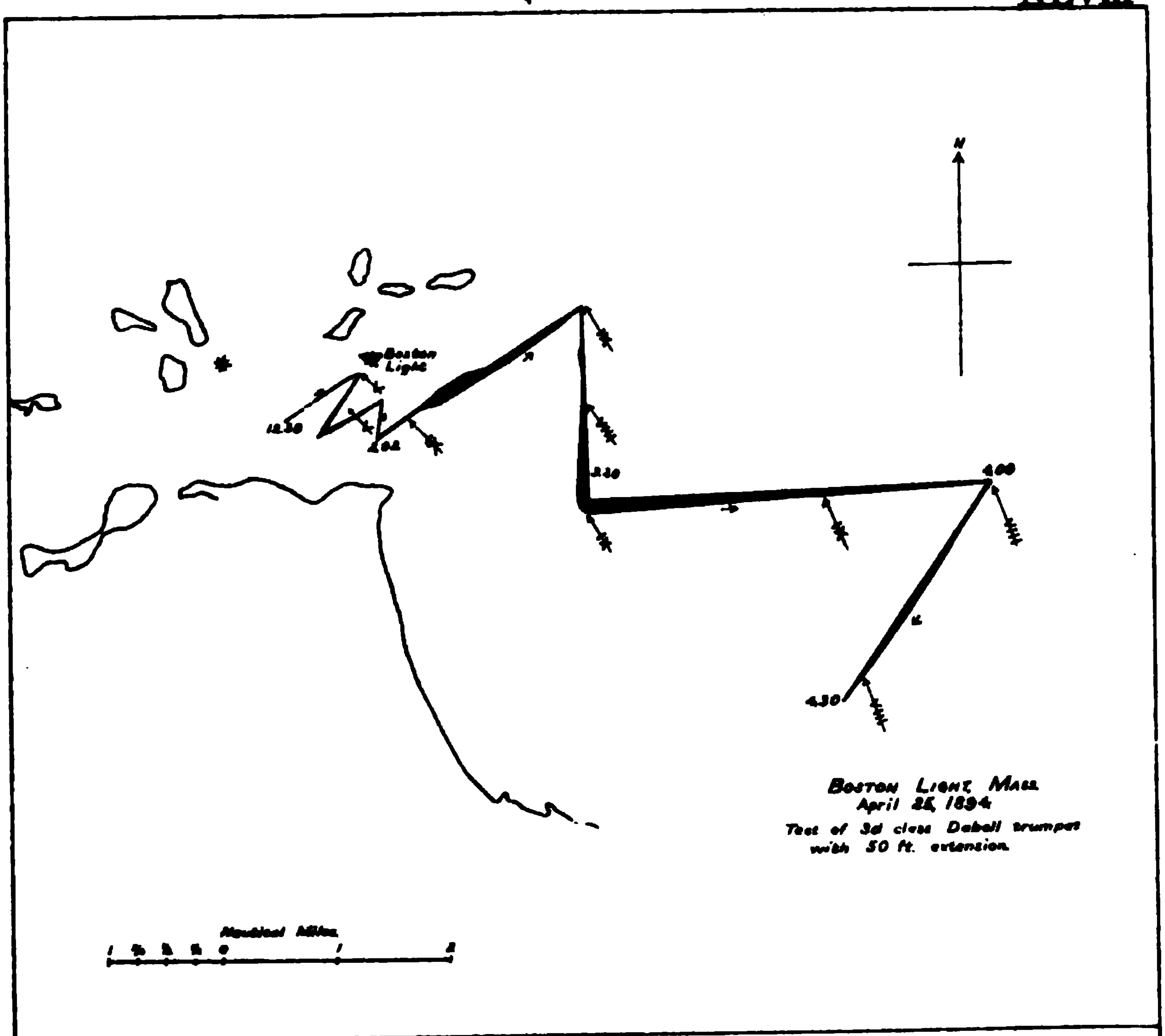
Boston Light
Pt. Allerton Beacon
Harding's Ledge
Minot's Ledge Lt.
N
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Boston Light, Mass.
March 28, 1894.
Test of air and steam sirens.
Course of Clover
Thermometer. Sea, 38° to 37°
Dry bulb, 39.0° to 34.5°
Wet bulb, 38.5° to 32.8°
Mast head, 38.5° to 34.0°
Cloudy, with rain and snow at times.
Steam siren.
Air siren.

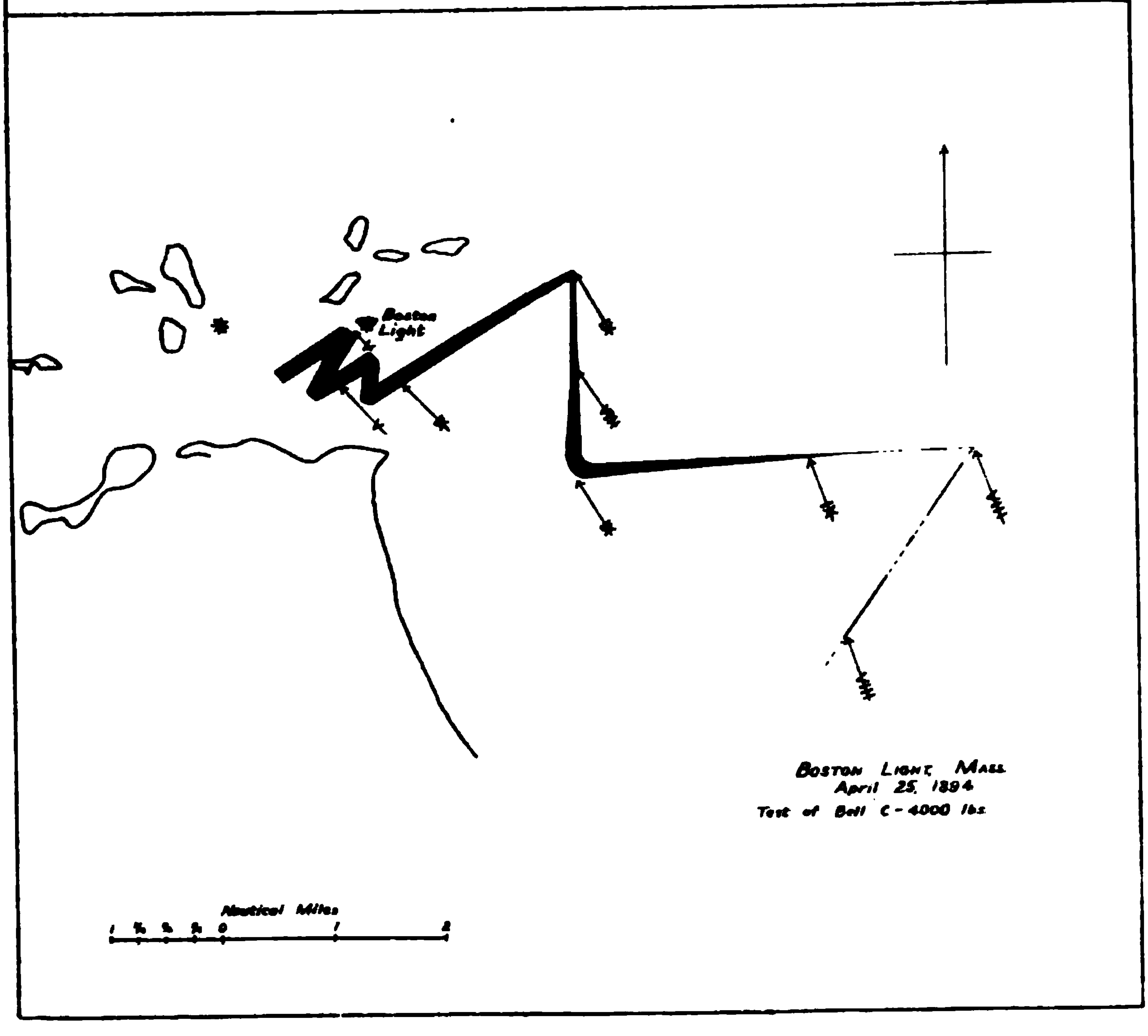


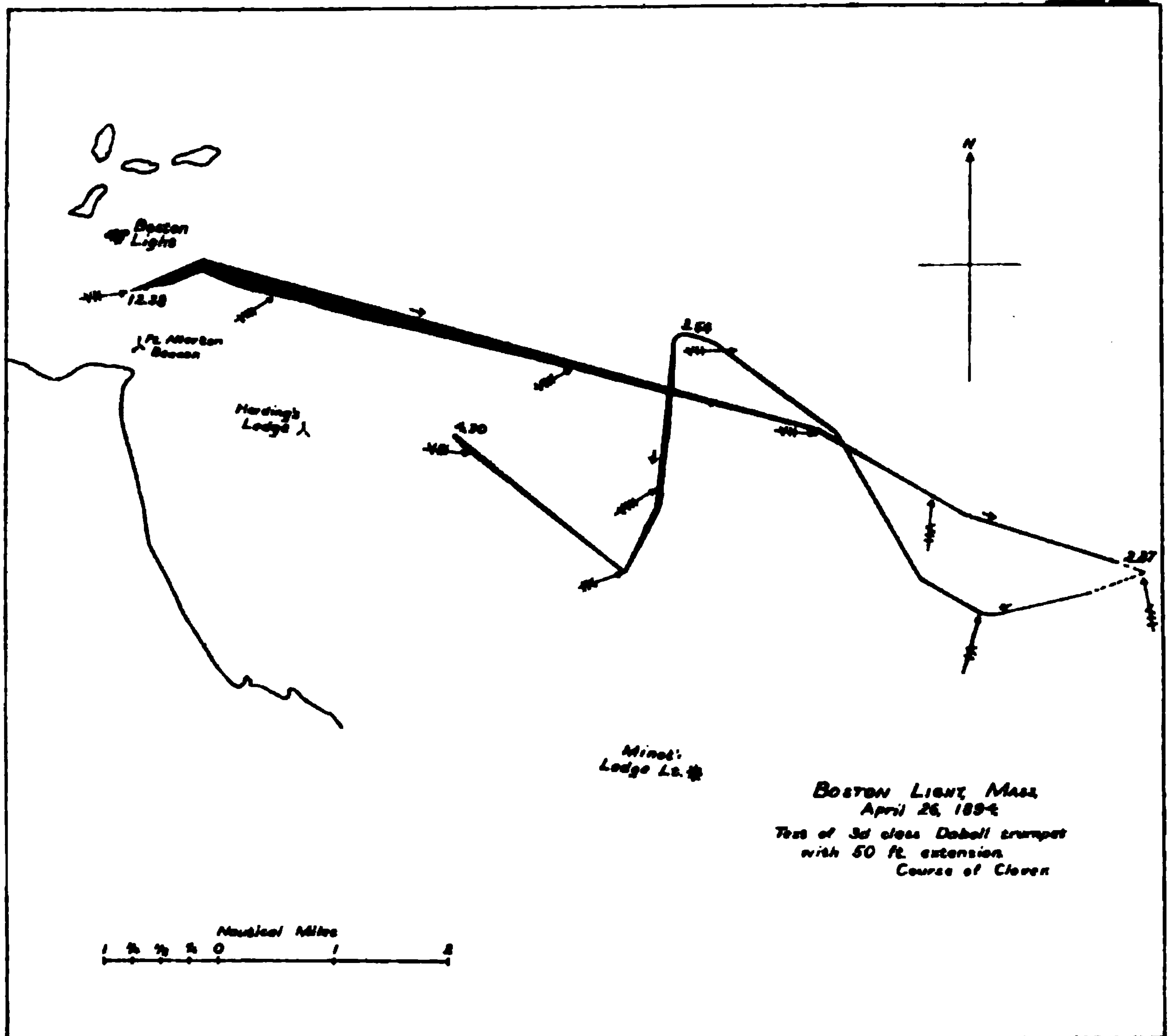
N
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Boston Light, Mass.
March 28, 1894.
Test of Bell C – 4000 lbs.
Course of Clover.
Conditions – see above.


Boston Light
Harding's Ledge
4.00
Minot's Ledge Lt.
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Boston Light, Mass.
March 22, 1894.
Test of air and steam sirens.
Course of Myrtle
Thermometer. Sea, 36° to 37°.
Dry bulb, 39.0° to 34.5°
Wet bulb, 33.5° to 32.8°
Mast head, 36.5° to 34.0°
Cloudy, with rain and snow at times.
Steam siren
Air siren

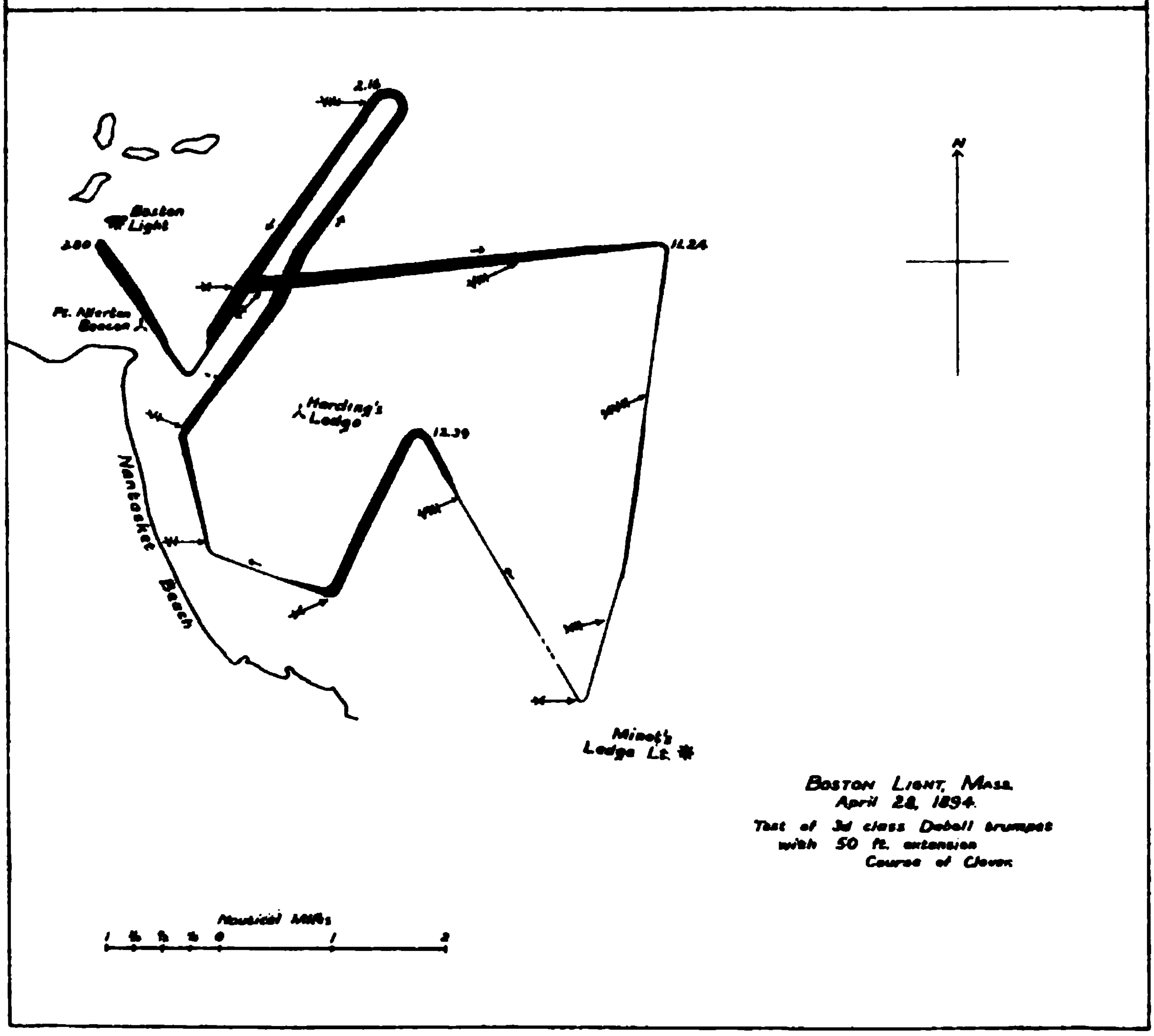

4.00
Nautical Miles
1 ¾ ½ ¼ 0 1 2
Boston Light, Mass.
March 22, 1894.
Test of Bell C – 4000 lbs.
Course of Myrtle.
Conditions – see above.


N
Boston Light
12.30
2.02
2.30
4.00
4.30
Boston Light, Mass.
April 25, 1894.
Test of 3d class Daboll trumpet
with 50 ft. extension.
Nautical Miles
1 ¾ ½ ¼ 0 1 2

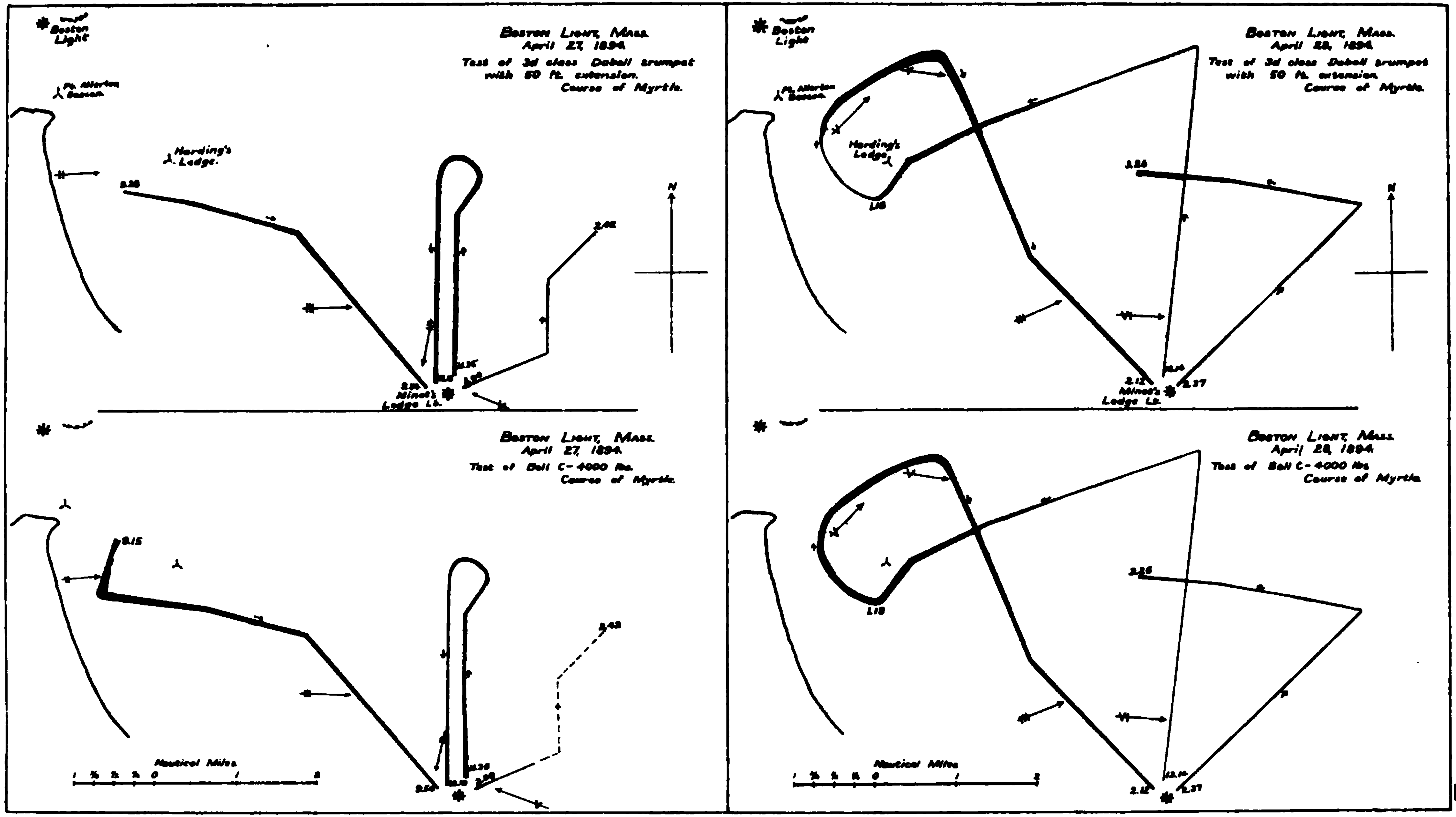

Boston Light
Boston Light, Mass.
April 25, 1894.
Test of Bell C - 4000 lbs.
Nautical Miles
1 ¾ ½ ¼ 0 1 2



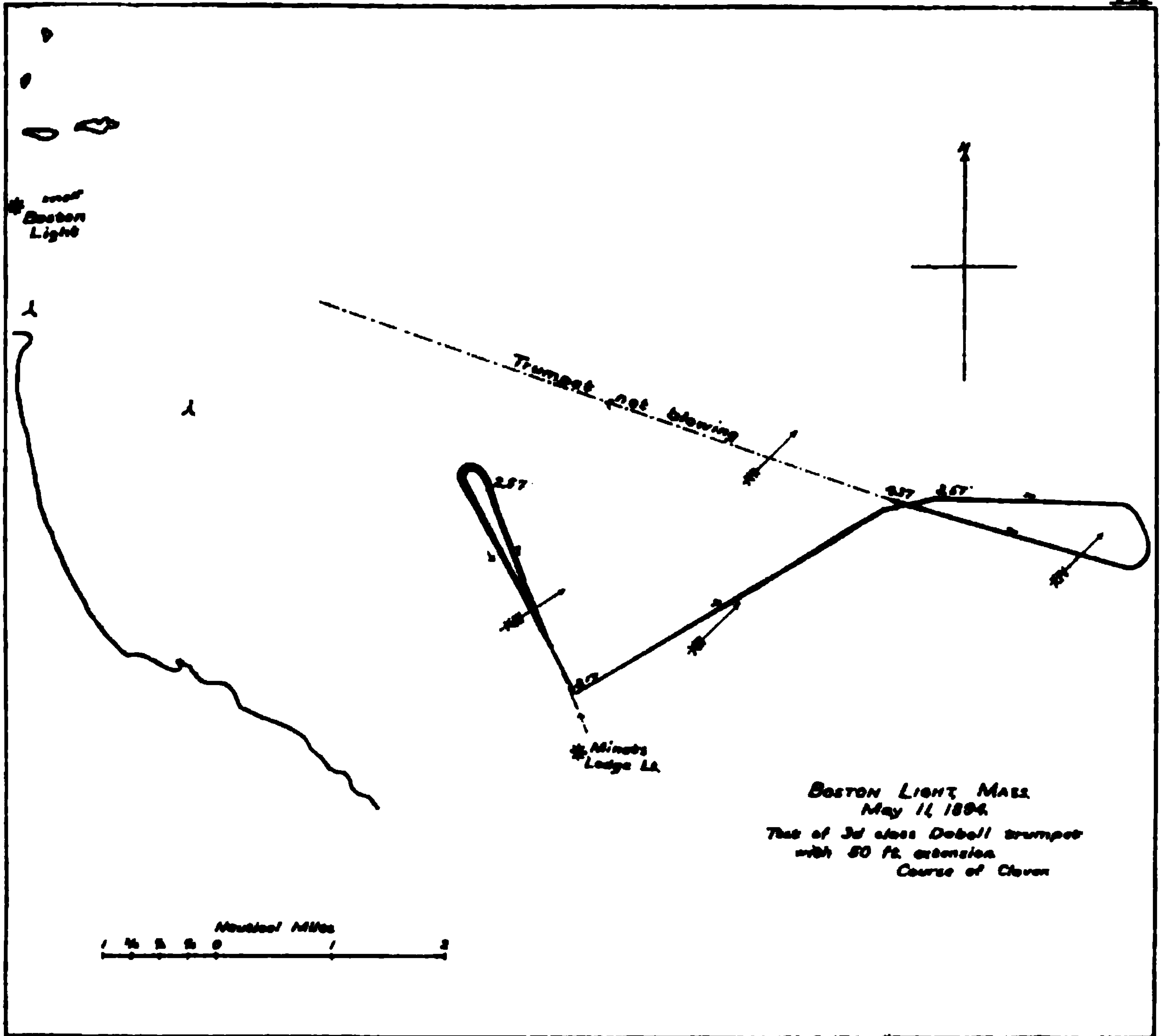
Boston Light, Mass.
April 26, 1894.
Test of 3d class Daboll trumpet with 50 ft. extension.
Course of Clover.



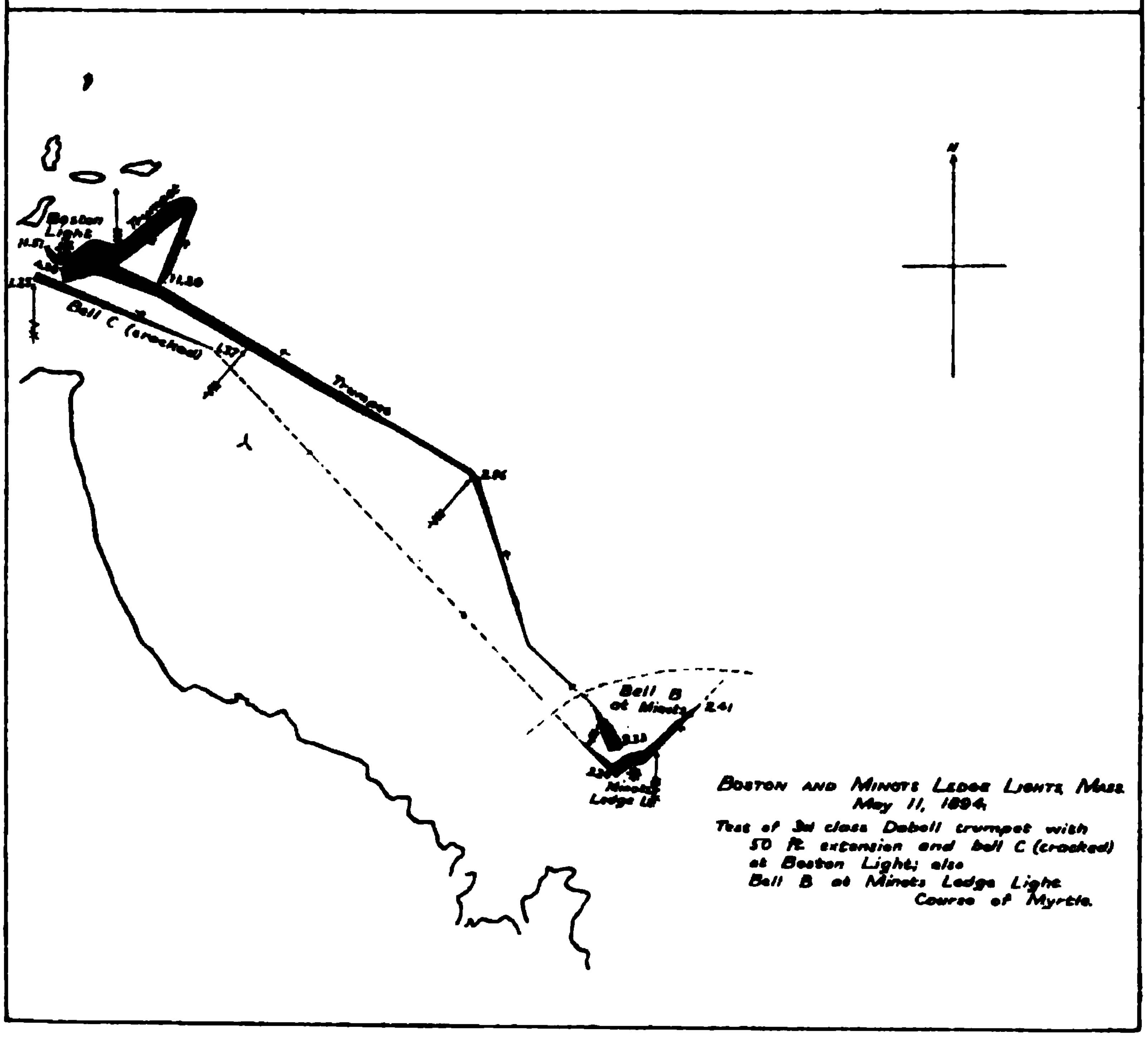
Boston Light, Mass.
April 28, 1894.
Test of 3d class Daboll trumpet with 50 ft. extension
Course of Clover.


Boston Light
Boston Light, Mass.
April 27, 1894.
Test of 3d class Daboll trumpet with 50 ft. extension.
Course of Myrtle.
Pt. Allerton Beacon.
Harding's Ledge.
Minot's Ledge Lt.
N
Boston Light, Mass.
April 27, 1894.
Test of Bell C-4000 lbs.
Course of Myrtle.
Nautical Miles
Boston Light
Boston Light, Mass.
April 28, 1894.
Test of 3d class Daboll trumpet with 50 ft. extension.
Course of Myrtle.
Pt. Allerton Beacon.
Harding's Ledge.
Minot's Ledge Lt.
Boston Light, Mass.
April 28, 1894.
Test of Bell C-4000 lbs.
Course of Myrtle.
Nautical Miles

L



Boston Light, Mass.
May 11, 1894.
Test of 3d class Daboll trumpet
with 50 ft. extension
Course of Clover



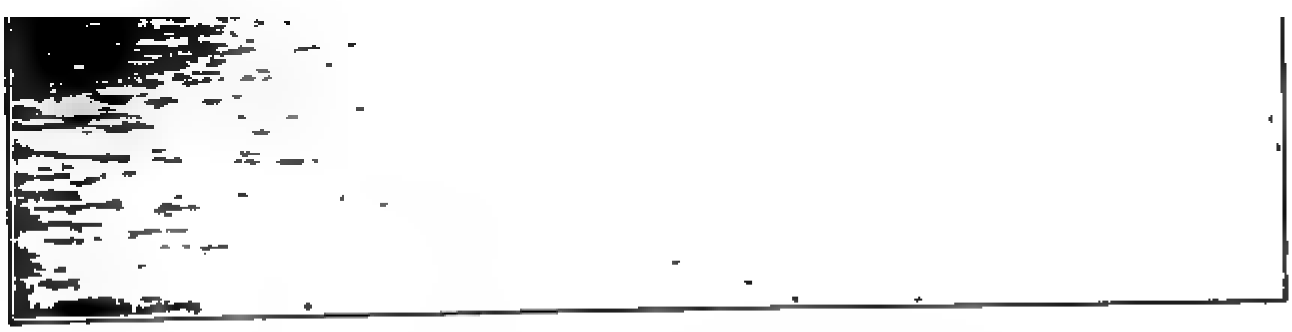
Boston and Minots Ledge Lights, Mass.
May 11, 1894.
Test of 3d class Daboll trumpet with
50 ft. extension and bell C (cracked)
at Boston Light; also
Bell B at Minots Ledge Light
Course of Myrtle.

WHITEHEAD

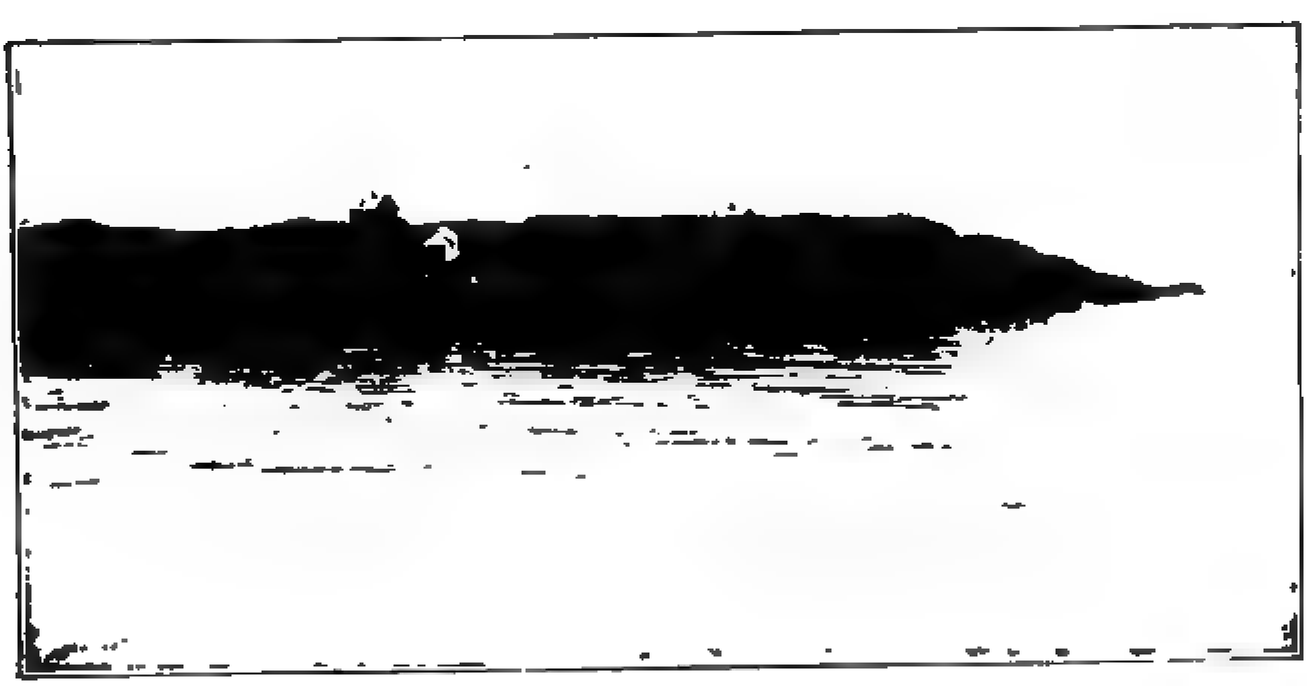
LIGHT STATION,

ME.

LIBBY ISLANDS LIGHT-STATION, LOOKING NW.

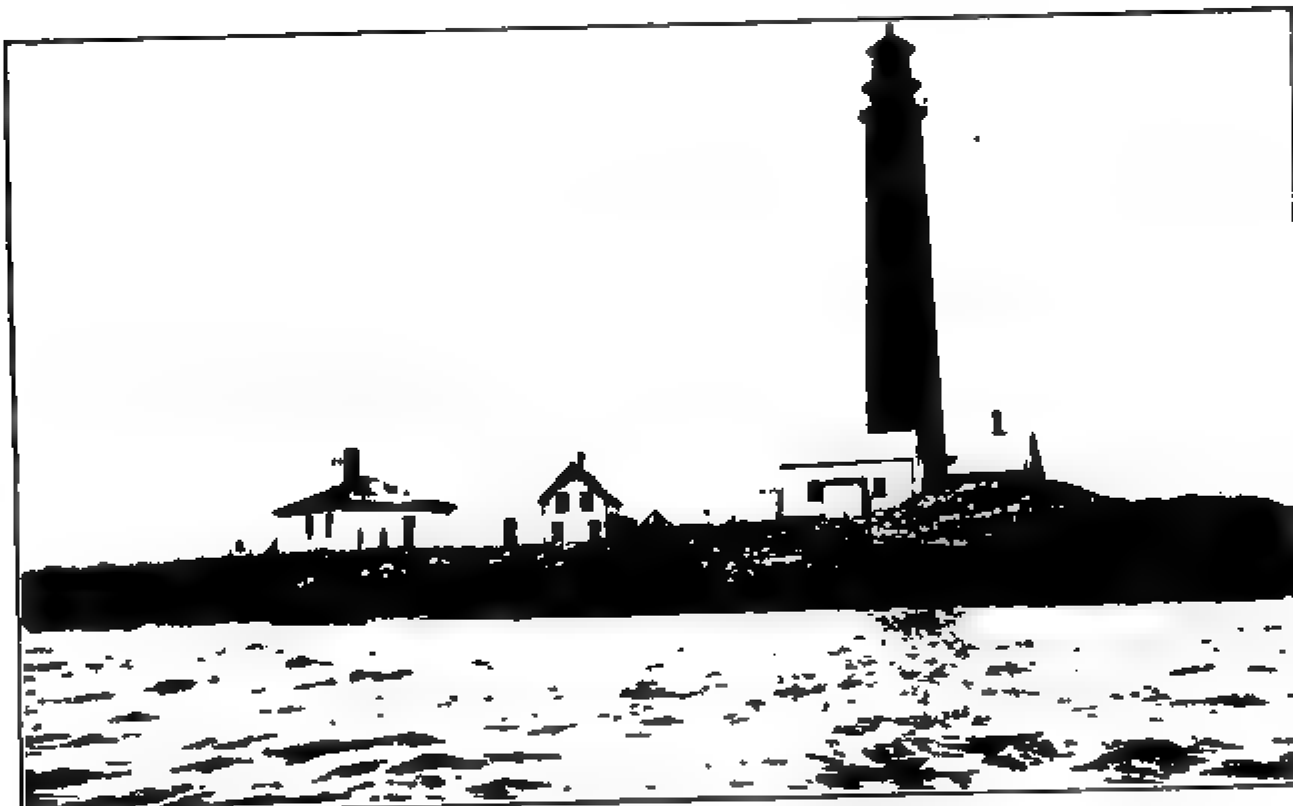


LIBBY ISLANDS LIGHT-STATION, LOOKING SE.

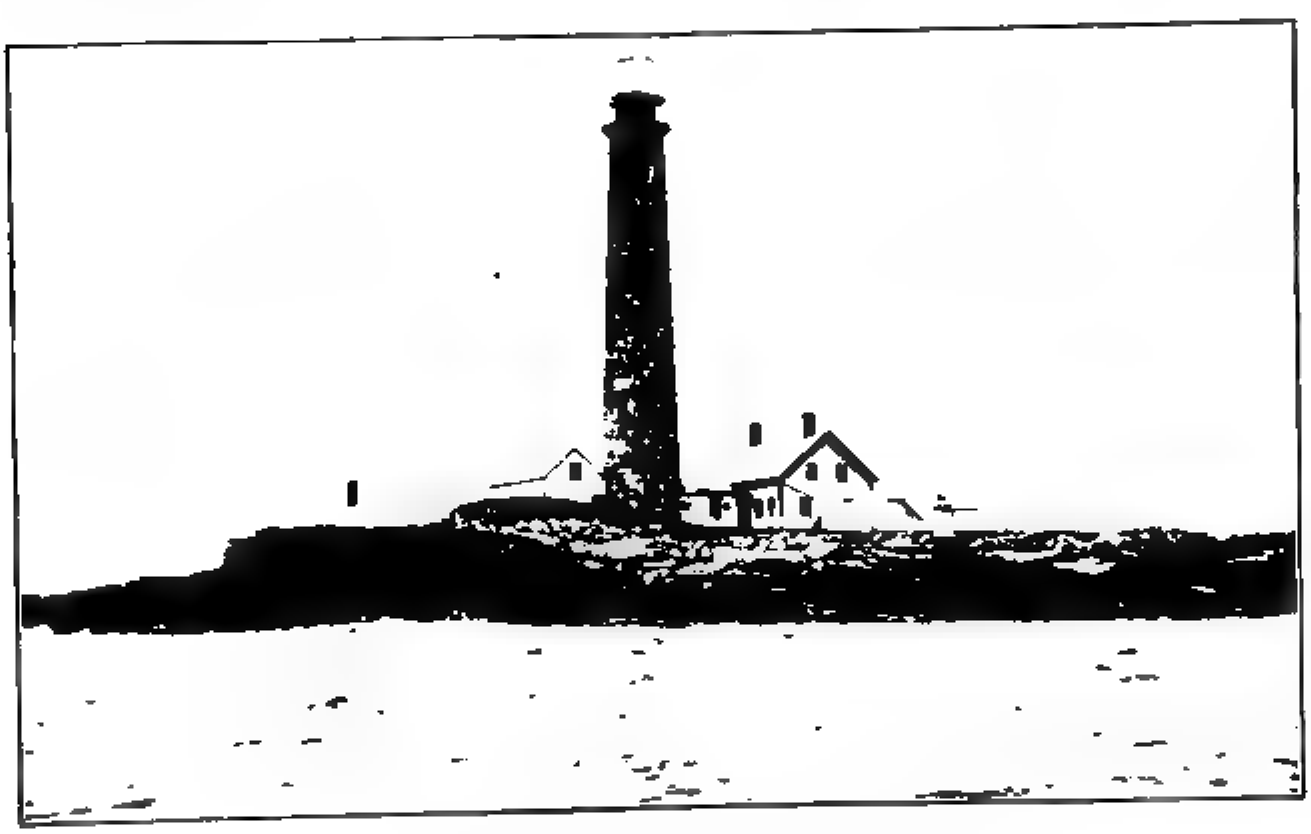


LIBBY ISLANDS LIGHT-STATION, LOOKING SW.

Petit Manan Light-station, looking W.



Petit Manan Light-station, looking W.



Petit Manan Light-station, looking SW.

PETIT MANAN LIGHT-STATION, LOOKING N.

PETIT MANAN LIGHT-STATION, LOOKING NE.

DEER ISLAND THOROUGHFARE LIGHT-STATION, LOOKING ENE.

Plate LVII.

Deer Island Thoroughfare Light-station, looking E.

Deer Island Thoroughfare Light-station, looking SE.

Deer Island Thoroughfare Light-station, looking SSE.

DEER ISLAND THOROUGHFARE LIGHT-STATION, LOOKING W.

MOUNT DESERT LIGHT-STATION, LOOKING NNE., BEFORE NEW DWELLING WAS ERECTED.

MOUNT DESERT LIGHT-STATION, LOOKING ENE.

MOUNT DESERT LIGHT-STATION, LOOKING S.

MOUNT DESERT LIGHT-STATION, LOOKING SW.

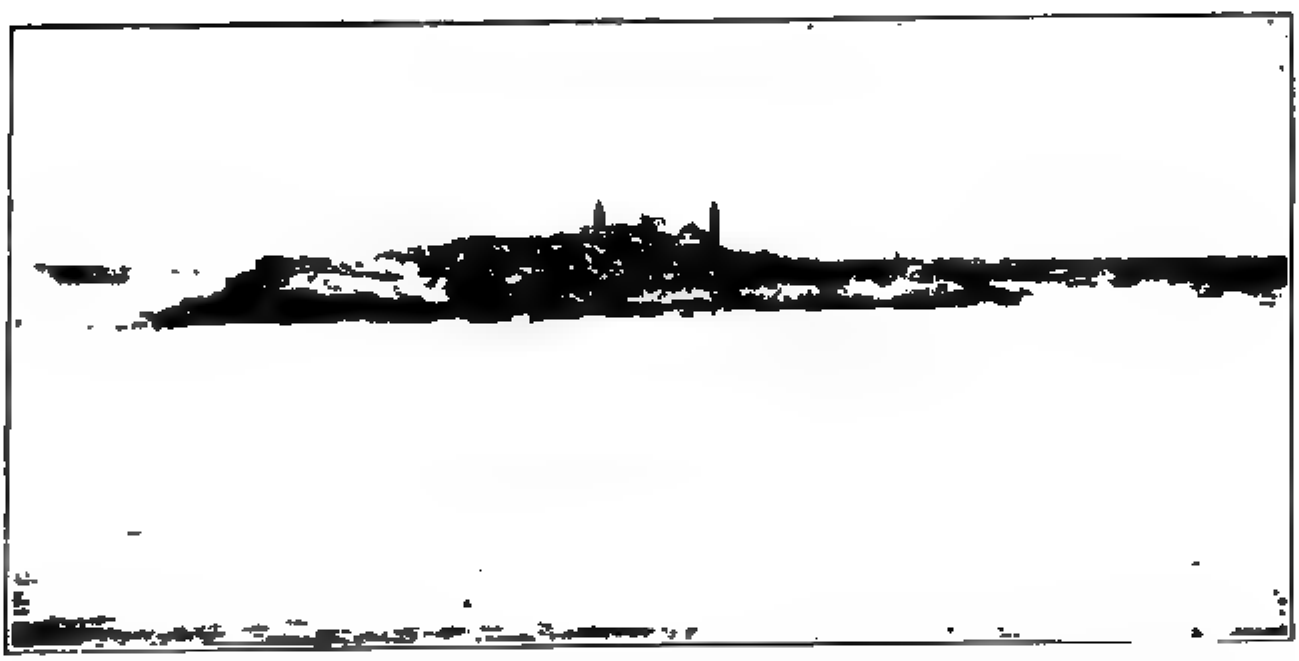
MOUNT DESERT LIGHT-STATION, LOOKING NW.

MOUNT DESERT LIGHT-STATION, LOOKING N.

MATINICUS ROCK LIGHT-STATION, LOOKING NE.

MATINICUS ROCK LIGHT-STATION, LOOKING ESE.

MATINICUS ROCK LIGHT-STATION, LOOKING SSE.



MATINICUS ROCK LIGHT-STATION, LOOKING SW.

MATINICUS ROCK LIGHT-STATION, LOOKING NW

PLATE LXII.

MATINICUS ROCK LIGHT-STATION, FROM NORTH LIGHT, LOOKING SSE.

WHITEHEAD LIGHT-STATION, LOOKING N.

WHITEHEAD LIGHT-STATION, LOOKING NE.

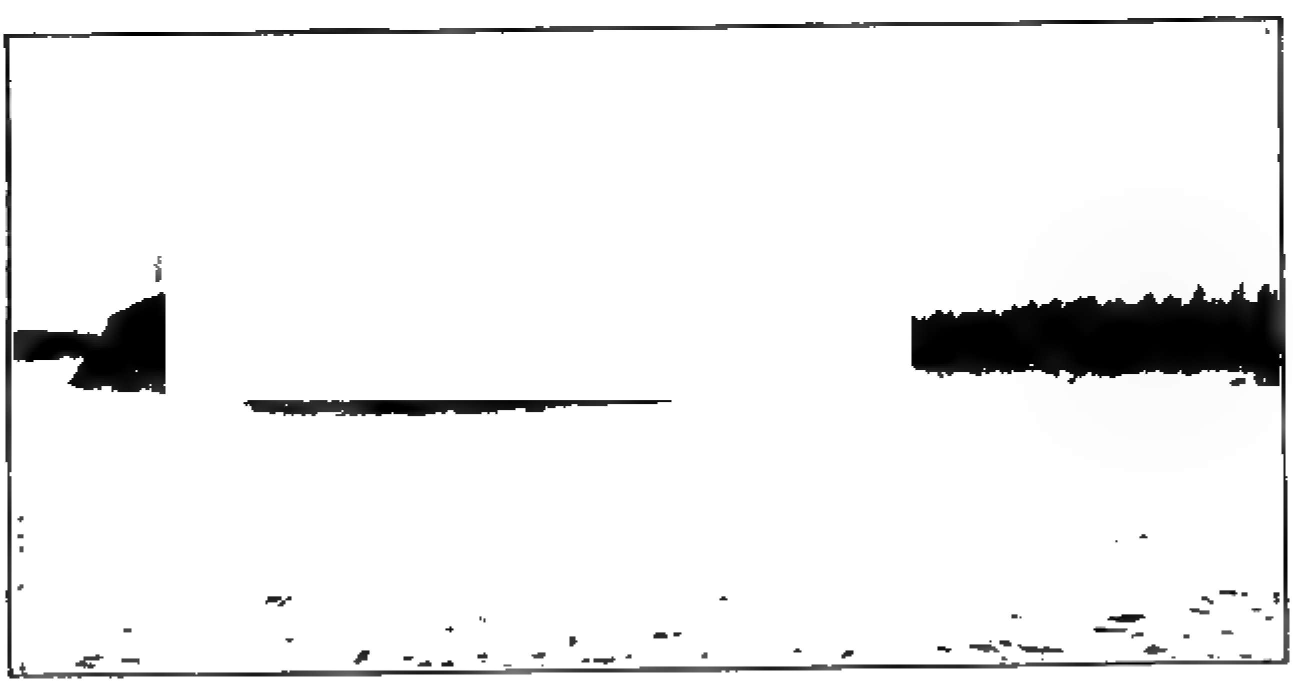
WHITEHEAD LIGHT-STATION, LOOKING W.

OWLS HEAD LIGHT-STATION, LOOKING NW.

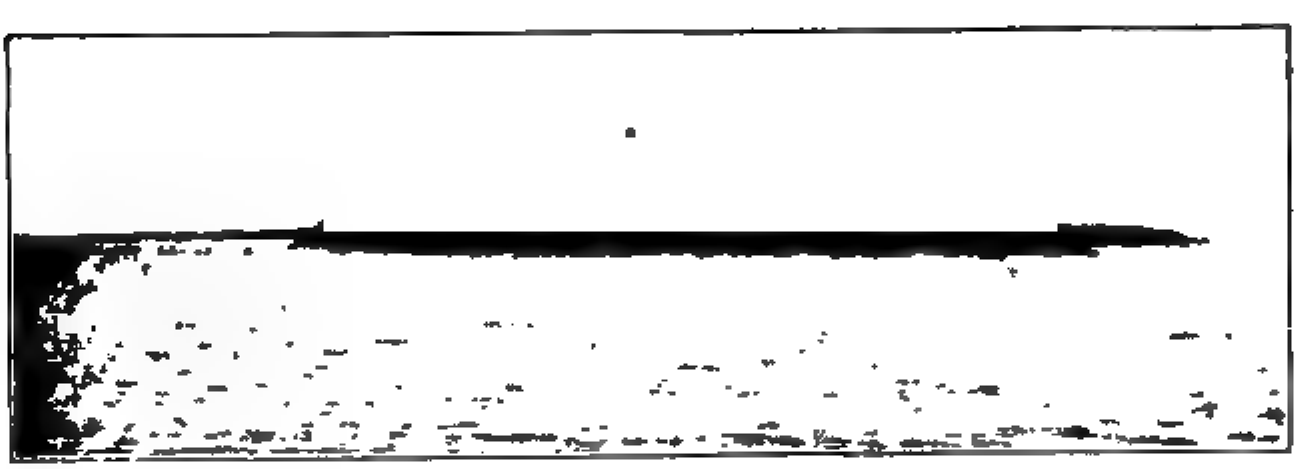
OWLS HEAD LIGHT-STATION, LOOKING NNW.

Plate LXIV.

Owls Head Light-station, looking N.



Owls Head Light-station, looking S.



Seguin Light-station, looking NNE.

SEGUIN LIGHT-STATION, LOOKING ENE.

SEGUIN LIGHT-STATION, LOOKING E.

SEGUIN LIGHT-STATION, LOOKING W.

PLATE LXVI.

SEGUIN LIGHT-STATION, LOOKING NE., FROM A POINT ABOUT 100 FEET W. OF SIGNAL-HOUSE.

SEGUIN LIGHT-STATION, LOOKING NW.

SEGUIN LIGHT-STATION, LOOKING SE.

CAPE ELIZABETH LIGHT-STATION, LOOKING N.

CAPE ELIZABETH LIGHT-STATION, LOOKING NW.

CAPE ELIZABETH LIGHT-STATION, LOOKING SSW.

Plate LXVIII.

Cape Elizabeth Light-station, looking WNW., from a point about 300 feet SW. of Signal-house.

Cape Elizabeth Light-station, looking NW., from a point about 500 feet NE. of Signal-house.

Cape Elizabeth Light-station, looking SW.

PLATE LXIX.

CAPE ELIZABETH LIGHT-STATION, LOOKING N. BY E., FROM A POINT ABOUT 200 FEET S. OF SIGNAL-HOUSE.

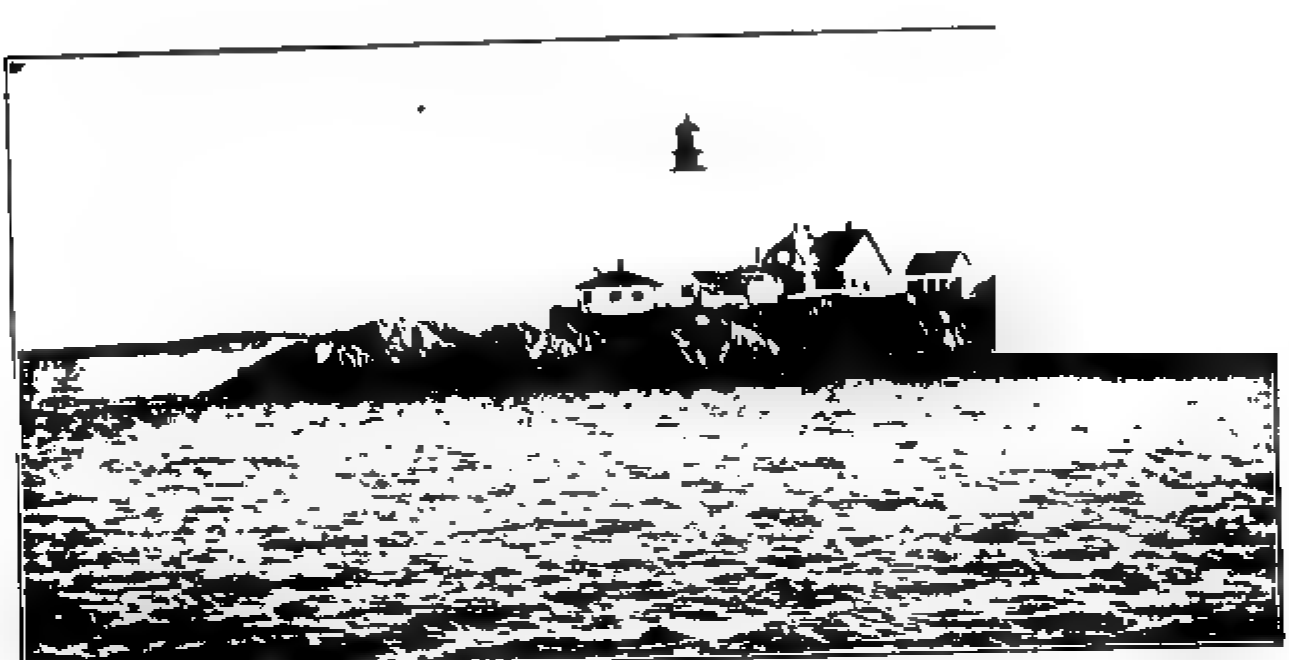
CAPE ELIZABETH LIGHT-STATION, LOOKING ESE.

CAPE ELIZABETH LIGHT-STATION, LOOKING SSE.

PLATE LXX.

CAPE ELIZABETH LIGHT-STATION, LOOKING NE.

PORTLAND HEAD LIGHT-STATION, LOOKING NE.



PORTLAND HEAD LIGHT-STATION, LOOKING SW.

PLATE LXXI.

BOSTON LIGHT-STATION, LOOKING E.

BOSTON LIGHT-STATION, LOOKING [illegible]

BOSTON LIGHT-STATION, LOOKING [illegible]

Plate LXXII.

Boston Light-station, looking SE.

Boston Light-station, showing trumpet extension, looking SW.

Boston Light-station, looking NW.

PLATE LXXIII.

BOSTON LIGHT-STATION, SHOWING EXPERIMENTAL BELLS AND HORNS, LOOKING NW.

BOSTON LIGHT-STATION, LOOKING DOWN ON TEMPORARY BUILDING.

LIGHT-HOUSE TENDER MYRTLE, 1893.

PLATE LXXIV.

MINOTS LEDGE LIGHT-HOUSE, LOOKING WSW.

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